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ABSTRACT

This publication is designed to support competency-based instruction in the sections of Natural Resources Management courses in Virginia devoted to forestry. It should be coordinated with both the "Task Analyses for Natural Resources Management" and the "Agricultural Education Service Area Resource." This guide contains 16 units, representing an expansion of the tasks/competencies identified in the natural resources task analyses guide. Each unit consists of a task analysis and a suggested lesson plan. The unit task analyses contain the following: one or more performance objectives that identify the competency to be achieved, the minimum standard of achievement, and the conditions under which the performance will be evaluated; enabling objectives; a criterion-referenced measure for each performance objective; and suggested instructional activities, audiovisual materials, and references. The suggested lesson plan is based on the task analysis and is presented in outline form, with four major sections: preparation, presentation, application, and evaluation. A bibliography and resource list providing 97 citations is provided. (KC)

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Forestry in Agricultural Education in Virginia

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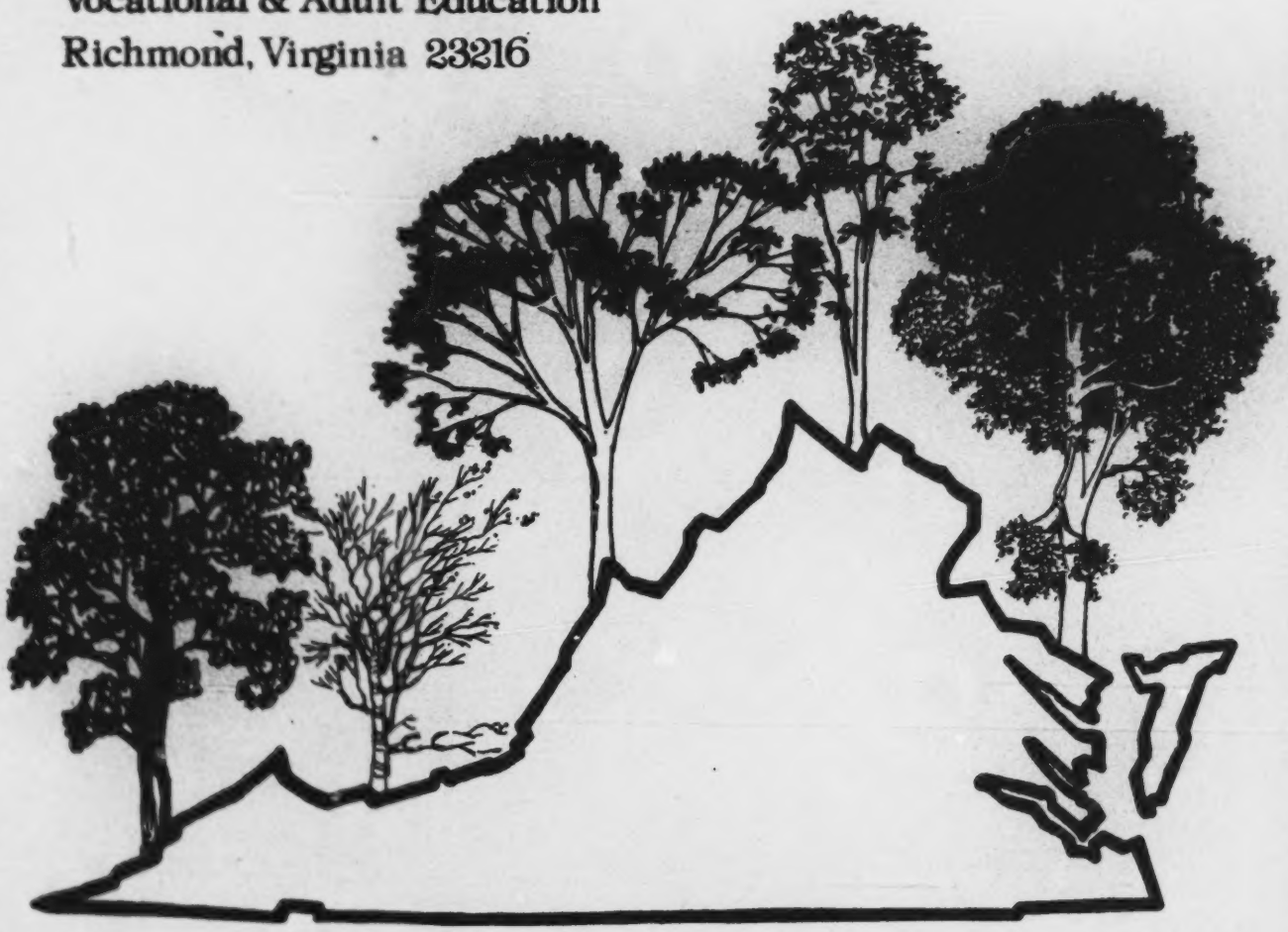

CE051006

1985
Review Draft

GUIDE APPLICATION

This publication is based on forestry-related competencies for the following Dictionary of Occupational Titles (DOT) job titles in the occupational domain of foresters and loggers:

All-Round Logger	454.684-018
Christmas Tree Farm Worker	451.687-010
Forest Worker	452.687-010
Forester Aide	452.364-010
Surveyor Helper	869.567-010
Tree Planter	452.687-018

This resource is useful in developing and selecting instructional materials and in implementing competency-based education for the following secondary level courses:

Program	Courses
Agricultural Resources (CIP 03.0101)	Natural Resources Management III (8040)
	Natural Resources Management IV (8042)
	Natural Resources Management V (8044)

Additional information concerning the application and use of these materials in program planning and development should be addressed to:

Agricultural Education Service
State Department of Education
P.O. Box 6Q
Richmond, Virginia 23216

Forestry in Agricultural Education in Virginia

Produced by

Virginia Vocational Curriculum Center
Department of Vocational and Community Education
Henrico County Public Schools
Glen Allen, Virginia 23060

in cooperation with

Agricultural Education Service
Department of Education
Vocational and Adult Education
Richmond, Virginia 23216

FOREWORD

In the next decade, businesses and industries in Virginia will require large numbers of skilled workers. Therefore, vocational education at the secondary and postsecondary levels will have the responsibility of preparing individuals for a variety of occupations.

Competency-based education (CBE) provides the preparation students need for entry into the Virginia work force. The CBE practice of recording competencies developed by students helps them to make a smooth transition between secondary and postsecondary programs when both levels of education are required for career training. In addition, CBE is effective in retraining workers who have been displaced because of changing technology.

This guide will assist teachers and administrators in developing instructional materials that meet the needs of students and industry and comply with the Virginia CBE standards for vocational and adult education.

S. John Davis
Superintendent of Public Instruction

Melvin H. Garner
Administrative Director
Vocational and Adult Education

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This publication is the result of a large updating and revision effort based on a 1970 edition of Forestry in Agricultural Education in Virginia. Members of the National Resources Management Advisory Council listed below are gratefully acknowledged for their technical expertise in updating and validating the lesson plan section:

Glenn A. Anderson, Supervisor, Agricultural Education, Virginia Department of Education
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Tom Reisinger, Industrial Forestry Operations, Virginia Polytechnic Institute and State University
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Sandy Silver, Forestry Department, Dabney S. Lancaster Community College
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Glenn A. Anderson, Supervisor, Agricultural Education, Virginia Department of Education
John Dickens, Assistant Professor, James Madison University.

The organization, editorial revisions, origination of many of the task analyses pages, original graphics (including the cover), and the entire production process were performed by the Virginia Vocational Curriculum Center, administered by the Henrico County Public Schools, Department of Vocational and Community Education:

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INTRODUCTION

This publication is designed to support competency-based instruction in the sections of Natural Resources Management courses devoted to forestry, and should be coordinated with both the Task Analyses for Natural Resources Management and the Agricultural Education Service Area Resource. Coordination guidelines are contained in the service area resource, and program and course information for this instructional area is included in the task analyses guide.

Forestry in Agricultural Education in Virginia contains 16 units, representing an expansion in depth of the task/competencies identified in the natural resources task analyses guide. Each unit consists of a task analysis and a suggested lesson plan.

The unit task analysis contains the following:

One or more performance objectives which identify for the student the competency to be achieved, the minimum standard of achievement, and the conditions under which the performance will be evaluated

Enabling objectives representing subskills or supporting concepts for the performance objective(s)

A criterion-referenced measure for each performance objective, restating the competency to be achieved and the standard and identifying the method of evaluation

Suggested instructional activities supporting the enabling objectives

Suggested audiovisual materials to be used during instruction

Suggested references for both teacher and student use.

The suggested lesson plan is based on the task analysis and is presented in outline form, with four major sections:

I. PREPARATION--This section contains the suggested lesson approach and motivational points, suggestions on how to coordinate the local situation with that existing in the state or nation, and tasks to be completed by the teacher prior to the beginning of instruction.

II. PRESENTATION--This section contains technical facts and illustrations supporting the subject matter, written to the student. It is designed to be used as a handout and is printed in full, starting on the page following the lesson plan outline.

III. APPLICATION--This section includes ideas on how the student can use the information in the presentation to achieve mastery of the identified competency.

IV. EVALUATION--This section contains suggestions on how to measure student achievement of the performance objective. Tests and checklists are not included, for reasons noted below.

Competency-based curriculum materials produced by the State Department of Education by necessity reflect a general statewide picture of the occupational areas covered by an instructional program. It is the responsibility of the local school system to tailor these materials to meet the needs of the students in the community. Tests and checklists prepared by the instructor will modify the materials presented in this guide in terms of both focus and depth of instruction.

It is suggested that the task sequence lists and course content outlines in Section 2 of the Task Analyses for Natural Resources Management be reviewed initially so that the additional tasks identified in this publication can, if desired, be inserted into the instructional sequence for a more in-depth presentation of forestry and its related industries.

FORESTRY IN AGRICULTURAL EDUCATION IN VIRGINIA
TASK LIST

1. Describe the forest industry in Virginia and its economic importance to the state
2. Identify the parts of a tree and explain the process of tree growth
3. Identify trees native to Virginia
4. Identify and explain the factors associated with the ecology of the forest
5. Interpret topography maps of the local forest area
6. Plan a timber stand improvement project
7. List and describe natural and artificial methods of tree reproduction
8. Survey a timber tract to determine its area
9. Describe how forest products are measured and marketed
10. Describe practices used to reduce erosion and preserve water quality on logging sites
11. Plan logging activities for a site and demonstrate selected tree-felling methods
12. Describe lumber processing and its role in total forest management
13. Demonstrate knowledge of the rules and terms associated with lumber grading
14. Develop a plan for growing and marketing Christmas trees
15. Develop a plan to protect a forest site against fire, disease, insects, and livestock
16. Identify and explain jobs and careers associated with forestry

Unit 1—Determining the Economic Importance of Trees

TASK ANALYSIS:

Performance Objective

Given access to the filmstrip Virginia's Forests--Importance to Our Economy, describe the forestry industry in Virginia and its economic importance to the state by completing the test at the end of the filmstrip. A score of 80 or above is required.

Enabling Objectives

1. Describe the economic value of the forest industry in Virginia.
2. List the uses made of forest products.
3. Describe the major forest industries in Virginia.
4. List trends that are affecting Virginia's forests.

Criterion-Referenced Measure

Describe the economic importance of forestry in Virginia by scoring 80 or above on the test at the end of the filmstrip Virginia's Forests--Importance to Our Economy.

Selected Instructional Activities

1. Have students report on the portion of land devoted to forest on their farms or a particular farm in the area.
2. Have students state the kind, amount, and value of the forest products harvested from that farm.

Selected Tools and Materials

Examples of wood products
Chalkboard
Projector (filmstrip)

Selected Audiovisual Materials

Filmstrip: Virginia's Forests--Importance to Our Economy. Filmstrip No. 1, Virginia Forest Series (#01750). Audiovisual Services, Virginia Department of Education.

Chart: What We Get From Trees. U.S. Department of Agriculture, Forest Service.

Selected References

Virginia's Timber, 1977. USDA, Forest Service Resource Bulletin SE-44.

Selected References (continued)

Virginia's Renewable Natural Resource Potential. VPI Extension Division, Publication 39.

Forestry in Virginia. VPI Agricultural Extension Service, Bulletin 223.

Agencies Furnishing Forestry Assistance to Virginia Landowners. VPI Agricultural Extension Service, Circular 632.

Virginia's Pine Resource, An Interim Assessment 1981. USDA, Forest Service Resource Bulletin SE-60.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. What is forestry? Forestry is the art, science, and business of managing forest land.
2. Forest landowners may have the following objectives for the management of forest holdings.
   a. To supply the fuel, fence posts, lumber, and other forest products needed for the operation of the farm.
   b. To contribute to the farm income through the sale of surpluses after providing for the farm requirements.
   c. To round out the farm labor year by providing profitable off-season work for farm labor and equipment.
   d. To make every forest acre a fully productive acre.
   e. To support local wood-using industries by growing species and quality needed.

B. General situation

1. Three-fourths of the farms in Virginia have forest land.
2. Forest land in Virginia has increased over the past 30 years. In 1940, 58% of the state was forested. In 1956, this increased to 63%, and in 1980, it was 64%.
3. There are many wood-processing plants in Virginia. Every county has forests and forest industry.

C. Local situation

Before presenting this lesson, prepare as follows:

1. Have each student provide the following information:
   a. The portion of land devoted to forest on his/her farm, or a form in the area.
   b. Kind, amount, and value of forest products furnished by the farm forest during the last year.
2. Summarize the information secured from the students.
3. Draw deductions from the summary of information and have them ready to present to the class.
4. If a local industry uses forest products, determine the amount and value of the forest products it uses annually.

II. PRESENTATION

The presentation, which may be duplicated for student use, follow the EVALUATION Section.

III. APPLICATION

Arrange a field trip to a local forest-related business. Prior to the trip, have students compose a list of questions to ask the management of the business concerning the importance of that business to the local economy. Questions should include, but not necessarily be limited to, the following:

1. What products are produced by the plant, and who buys the products?
2. What determines the price of the products?
3. What percentage of the raw materials for these products comes from the local area?
4. How many local citizens are employed?
5. How much added income to the local area is the result of this plant operation?

IV. EVALUATION

Test at end of filmstrip--score of 80 or above required.

THE ECONOMIC IMPORTANCE OF FORESTRY

II. PRESENTATION

A. Virginia's forests—how they serve us

Virginia is a timber-growing state. Adequate rainfall, long growing season, and soils adapted to trees make Virginia competitive with any state in the country as a timber producer. Many people fail to realize the importance of our forests. A brief study of the forest industry and the land area devoted to forests will aid us in seeing the value of Virginia's timberland.

1. Economic value

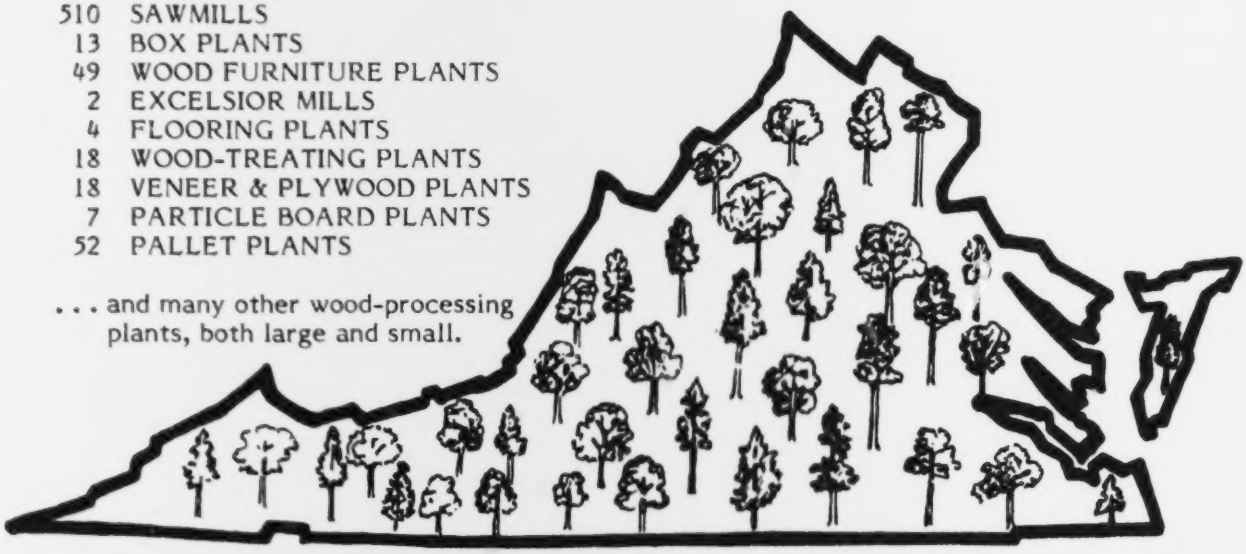
1980 Survey of Virginia Manufacturers

Value Data	Forest Industries (Lumber, pulp, paper, furniture, etc.)	Other Industries (Tobacco, textile, chemical, etc.)	Percent of Forest Industry Total
Persons Employed	63,000	350,800	15.0%
Salaries & Wages	$800,488,000	5,258,655	13.0%

Many more Virginians gain a part or all of their living from business directly or indirectly dependent on forest products; for example, the printing and building trades or the railroads and trucking companies. Timberland and wood processing plants are not sectionalized. Every county has forest land and forest industry.

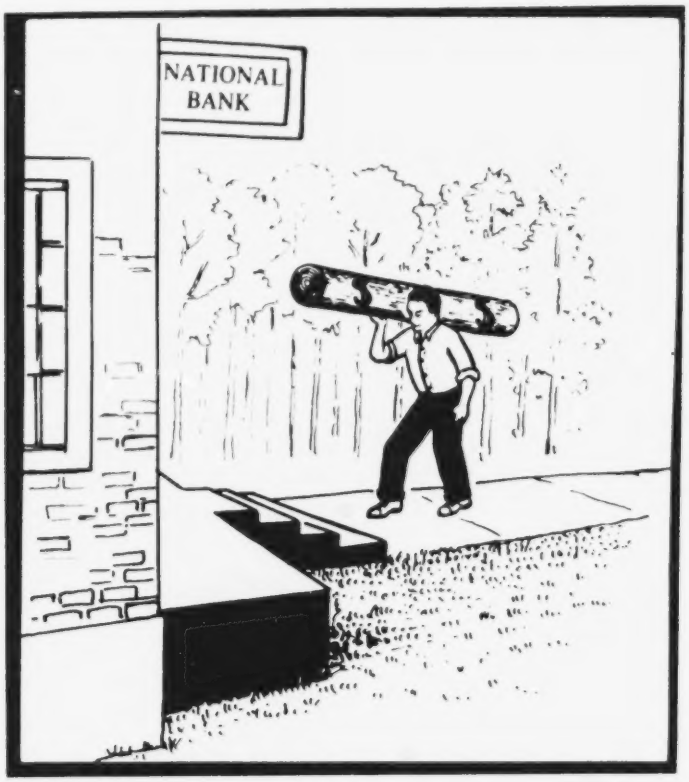
VIRGINIA HAS . . . .
- 7 PULP MILLS
- 510 SAWMILLS
- 13 BOX PLANTS
- 49 WOOD FURNITURE PLANTS
- 2 EXCELSIOR MILLS
- 4 FLOORING PLANTS
- 18 WOOD-TREATING PLANTS
- 18 VENEER & PLYWOOD PLANTS
- 7 PARTICLE BOARD PLANTS
- 52 PALLET PLANTS

. . . and many other wood-processing plants, both large and small.



II. A. 1. (Continued)

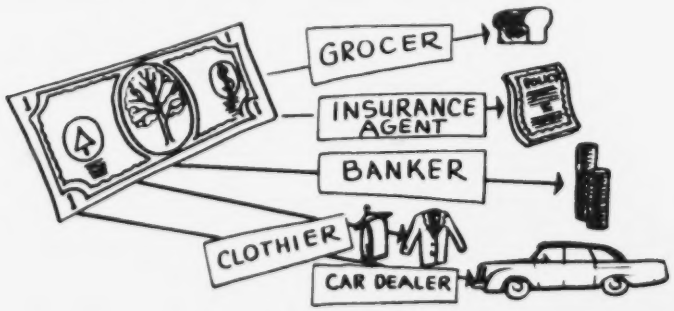
Thousands of landowners harvest tree crops for cash. Millions of dollars are realized each year from the sale of the forest crop; thousands work full-time or part-time in the woods. Each year Virginians cut over 1 billion board feet of lumber and 2-1/4 million cords of pulpwood, together with great quantities of other forest products.



To many landowners, a growing timber crop is "money in the bank." Also, landowners need fence posts, lumber for buildings, and other forest products. By growing them on their own land, they can save money.

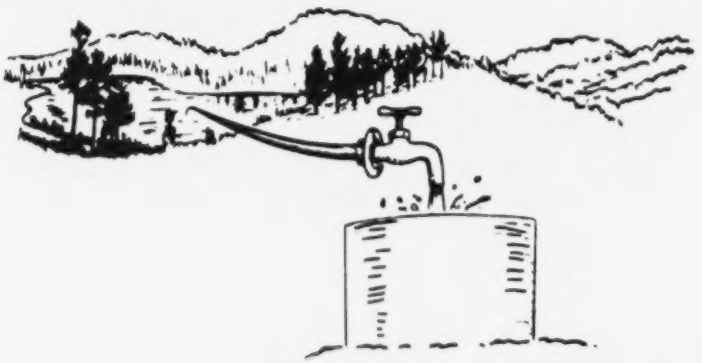
The forest dollar is new wealth created from a renewable natural resource. It helps support the noncreative businesses and services.

A part of the forest dollar supports the grocer, clothier, insurance agent, banker, auto dealer, and many, many others.



II. A. 2. **Watershed value**

All of us depend upon water every day. Our farms need water for crops and animals; our homes for cooking, washing, and drinking; our towns and cities for fire fighting, sanitation, and recreation; and our industries for manufacturing processes. Virginians consume the equivalent of 60 gallons per day for each person.



A well managed forest provides the best protection for a watershed. The leaves and branches of trees and shrubs break the force of falling rain, and the dead plant material on the ground serves as a "big sponge" to soak up the rain and release it slowly into the soil beneath. The roots help to anchor the soil, preventing destructive erosion that silts the rivers, lakes, and reservoirs.

Forests help prevent disastrous floods and provide water vital to life.

3. **Recreational value**

Increasing population and shorter working hours create more demand for outdoor recreation. Virginia's forests are the home for wildlife which supports a multi-million dollar industry.

Thousands of tourists enjoy Virginia's forest beauty, spending over three billion dollars annually. Fishing, boating, and other water enthusiasts spend millions for equipment to use on lakes and streams fed from and surrounded by forests.

B. **What we get from trees**

Thousands of useful items come from trees, from charcoal for the outdoor grills to medicine to cure our ills. Wood, even in the raw form, has fascinating qualities. It is highly rated as a radiation shield and as an insulator. It is resilient: think of its use as handle stock for pounding tools such as hammers and axes. There is no substitute for the wooden cross tie for railroad construction. Vanilla extract food flavoring is a product of the tree. Rosin used by violinists and boxers comes from our pines. The finest gun stock material in the world is made from America's black walnut. Wood has beauty, warmth, and strength; it is the favorite material for furniture making. Wood, in its many forms and by-products, is a vital component of the space program.

II. B. (Continued)

Not to be overlooked are the simple things such as shade from the hot sun, food for hungry people or animals, and logs for the stove or fireplace.

Wood, in its thousands of forms, is an integral part of the American way of life.

C. **Virginia's forested area**

Two out of three acres in Virginia are forest land.

Forest Area Capable of Producing Commercially Valuable Trees

COUNTY OR MUNICIPALITY	TOTAL LAND AREA 1,000 ACRES	COMMERCIAL FOREST AREA 1,000 ACRES	PERCENT OF COUNTY FORESTED
Accomack	304,640	114,092	37.5
Albemarle	480,640	291,386	60.6
Alleghany	289,280	251,237	86.8
Amelia	233,911	170,791	73.0
Amherst	300,763	232,994	77.5
Appomattox	220,800	154,961	70.2
Arlington	16,640	0	0
Augusta	641,280	318,822	49.7
Bath	345,600	296,962	85.9
Bedford	493,263	292,451	59.3
Bland	236,160	173,604	73.5
Botetourt	350,507	244,440	69.7
Brunswick	366,933	290,505	79.2
Buchanan	325,120	271,192	83.4
Buckingham	372,480	298,646	80.2
Campbell	352,339	222,295	63.1
Carroll	318,720	185,854	58.3
Caroline	346,524	263,294	76.0
Charles City	115,840	87,509	75.5
Charlotte	301,259	207,387	68.8
Chesapeake	270,720	113,784	42.0
Chesterfield	303,594	211,294	69.6
Clarke	111,360	34,291	30.8
Craig	215,040	175,219	81.5
Culpeper	248,960	107,768	43.3
Cumberland	186,880	132,252	70.8
Dickerson	214,080	176,529	82.5

II. C. (Continued)

COUNTY OR MUNICIPALITY	TOTAL LAND AREA 1,000 ACRES	COMMERCIAL FOREST AREA 1,000 ACRES	PERCENT OF COUNTY FORESTED
Dinwiddie	327,609	246,146	75.1
Essex	160,000	107,164	67.0
Fairfax	268,593	105,435	39.3
Fauquier	422,400	191,790	45.4
Floyd	245,120	136,861	55.8
Fluvanna	184,141	134,086	72.8
Franklin	452,769	294,675	65.1
Frederick	279,040	143,151	51.3
Giles	232,257	170,265	73.3
Gloucester	145,920	96,044	65.8
Goochland	188,800	136,607	72.4
Grayson	291,200	155,892	53.5
Greene	97,920	51,983	53.1
Greenville	192,640	138,074	71.7
Halifax	513,824	336,266	65.4
Hampton	35,200	6,523	18.5
Hanover	301,380	198,593	65.9
Henrico	161,854	71,760	44.3
Henry	251,857	170,457	67.7
Highland	266,240	195,717	73.5
Isle of Wight	202,880	123,178	60.7
James City	100,480	62,651	62.4
King & Queen	230,520	160,961	79.1
King George	112,640	69,762	61.9
King William	178,133	125,112	70.2
Lancaster	87,680	51,686	58.9
Lee	280,320	159,989	57.1
Loudoun	330,340	111,614	33.8
Louisa	324,743	234,104	72.1
Lunenburg	283,520	211,760	74.7
Madison	209,280	97,685	46.7
Mathews	56,960	34,106	59.9
Mecklenburg	407,136	246,513	60.5
Middlesex	83,200	53,831	64.7
Montgomery	355,854	149,584	58.5
Nelson	301,440	283,094	79.0
New Kent	132,762	101,407	76.4
Newport News	44,160	15,442	35.0
Northampton	140,800	31,586	22.4
Northumberland	121,600	69,188	56.9
Nottoway	197,120	137,206	69.6
Orange	226,959	131,845	58.1
Page	202,240	85,840	42.4
Patrick	299,196	220,037	73.5
Pittsylvania	656,378	392,910	59.9
Powhatan	173,853	126,358	72.7

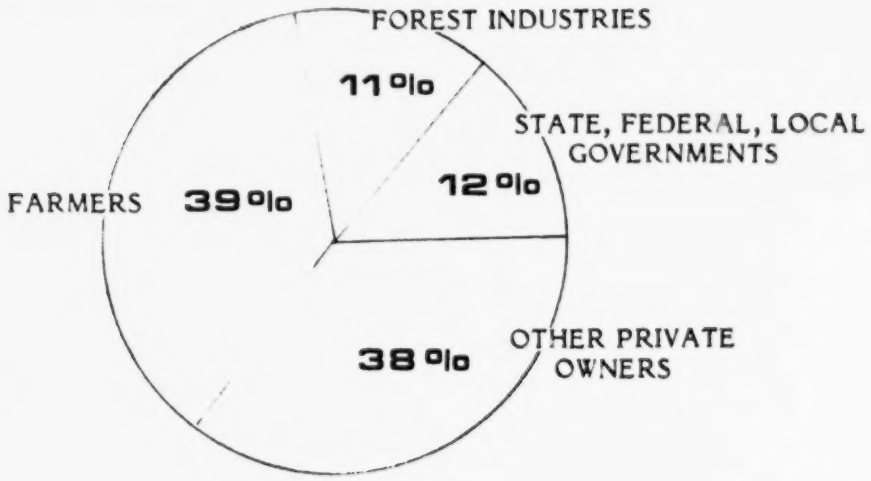
II. C. (Continued)

COUNTY OR MUNICIPALITY	TOTAL LAND AREA 1,000 ACRES	COMMERCIAL FOREST AREA 1,000 ACRES	PERCENT OF COUNTY FORESTED
Prince Edward	228,480	163,327	71.5
Prince George	184,040	119,660	65.4
Prince William	222,122	104,606	47.1
Pulaski	213,143	116,113	54.5
Rappahannock	170,880	74,756	43.7
Richmond	121,600	79,027	65.0
Roanoke	193,920	114,165	58.9
Rockbridge	388,109	249,091	64.2
Rockingham	557,440	259,963	46.6
Russell	309,120	159,563	51.6
Scott	344,960	230,360	66.8
Shenandoah	324,480	185,560	57.2
Smyth	278,400	173,650	62.4
Southampton	387,840	263,927	68.1
Spotsylvania	263,472	184,139	69.9
Stafford	173,829	123,166	70.9
Suffolk	262,400	134,912	51.4
Surry	177,280	133,958	75.6
Sussex	316,160	248,554	78.6
Tazewell	334,080	204,713	61.3
Virginia Beach	165,760	57,598	34.7
Warren	140,160	71,154	50.8
Washington	371,310	189,973	51.2
Westmoreland	146,560	86,931	59.3
Wise	265,600	210,513	79.3
Wythe	294,400	148,437	50.4
York	82,560	35,280	42.7

Total Land Area	25,512,396 acres
Forest Area	16,417,379 acres
Percent Forested	64%
Commercial Forest Acres	15,972,793 acres

The difference between total forest area and commercial forest area is 444,586 acres. A little over half of this acreage is in national and state parks, where commercial timber cutting is prohibited. The remaining acreage is land that is too poor to grow commercially valuable trees. Much of it is rock outcrop or marsh land adjacent to or located within commercial forest areas. For general survey purposes, this acreage is considered forest land and must be protected from fire.

II. D. **Who owns Virginia's forest land?**



During the period between forest surveys (1966-1977), timberland acreage changed hands.

Area of Commercial Forest Land, by Ownership Classes

OWNERSHIP CLASS	1966 Area	1977 Area
	Thousand Acres	
National Forest	1,202.8	1,457,989
Other Federal		
Indian	0.5	485
Miscellaneous Federal	233.9	245,126
Total Other Federal	234.4	245,611
State	181.6	183,345
County and Municipal	53.1	68,985
Forest Industry	1,562.3	1,669,618
Farmer Owned	6,958.2	6,209,938
Miscellaneous	5,619.9	6,137,309
Total All Ownerships	15,809.3	16,218,406

II. E. The changing forest picture

1. History

Forests have played a vital role in making our country a great nation. The harvest of Virginia's forests began when English settlers landed at Jamestown. Wood products were among the first export goods from the colony, thus laying the foundation for forest industry so important to Virginia today.

As our civilization moved westward, new uses for the tree and its products were developed. The rapid development from a frontier to our present civilization is partly due to our forest resources. This early period was one of exploitation; the virgin forests were heavily cut and burned. It was a time of land-clearing for agriculture and a time of "cut out and get out" for wood industry.

This great expansion era created problems for the forests. But our forests, although exhaustible, can be renewed. Unlike oil and minerals, timberland can be kept in continuous production--it is not necessary to exhaust an area of forest and move to a new location. The course will tell us how to restore and manage woodlands properly. The forest is a renewable resource.

2. The present status of Virginia's forest resource

Virginia's Major Forest Types in Acres of Commercial Forest Land (From forest surveys of 1940, 1957, 1966, and 1977)

	1940	1957	1966	1977
Pine and Oak-Pine Type	6,230.6	5,909.4	5,519.2	5,369.1
Hardwood Type	8,181.6	9,540.5	10,290.1	10,603.7
TOTAL	14,412.2	15,449.9	15,809.3	15,972.8

Some of the increase in hardwood acreage is at the expense of pine. Hardwoods, because of their tolerance, often "take over" an area.

Volume of Timber in Virginia by Forest Surveys

Species Group	1940 Mil. Cu. Ft.	1957 Mil. Cu. Ft.	1966 Mil. Cu. Ft.	1977 Mil. Cu. Ft.
Softwood	4,729.1	4,790.9	4,624.4	5,699.7
Hardwood	9,607.6	12,356.6	13,651.3	17,556.6

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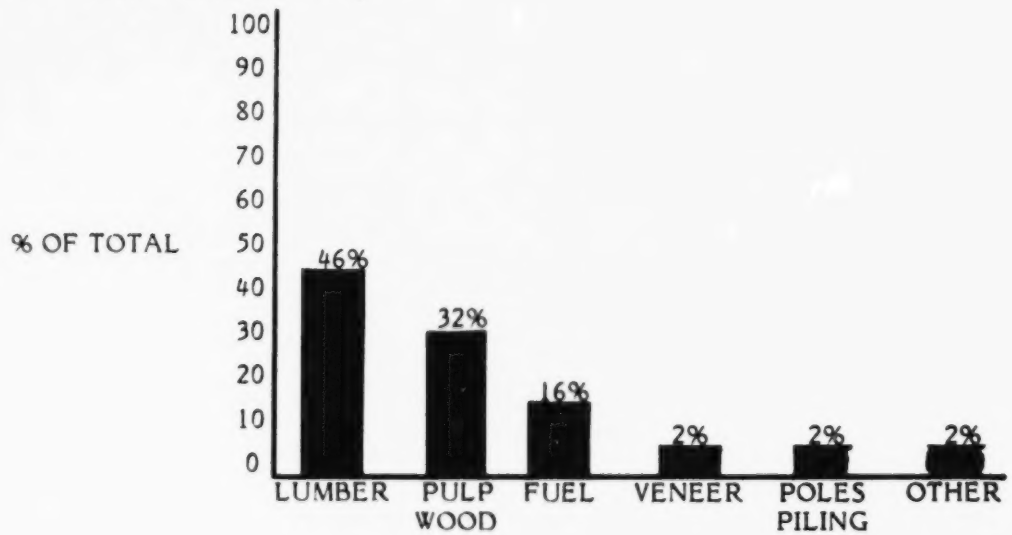
II. E. 2. (Continued)

Pulpwood Production* in Cords

Year	Round Wood	Chips	Residues	TOTAL
1977	1,680,200	862,000	95,400	2,637,600
1978	1,768,500	745,400	115,400	2,629,300
1979	1,638,500	842,700	185,500	2,666,700
1980	2,048,341	969,000	128,900	3,146,241
1981	2,254,287	855,000	54,000	3,163,287

*Veneer cores, pole and piling trim, cull material, sawdust, and secondary residues.

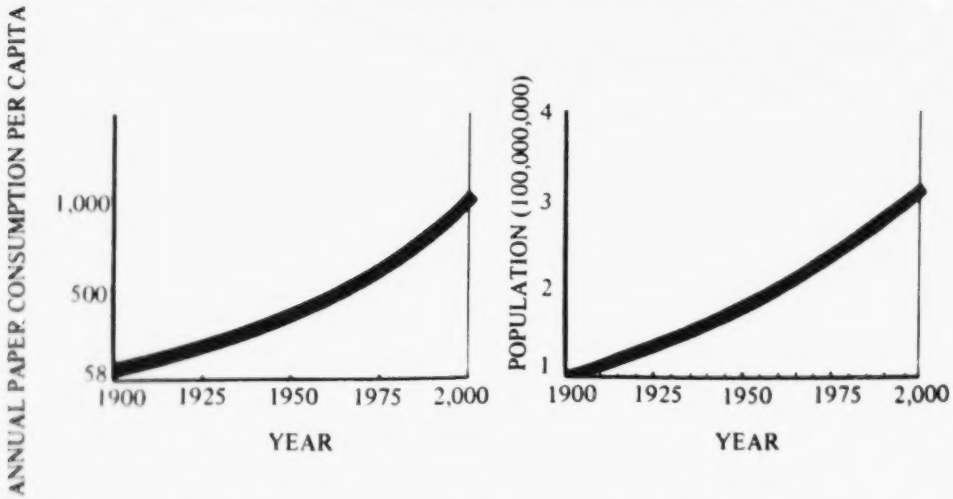
3. **Uses of the forest crop**



II. E. 4. **Future status**

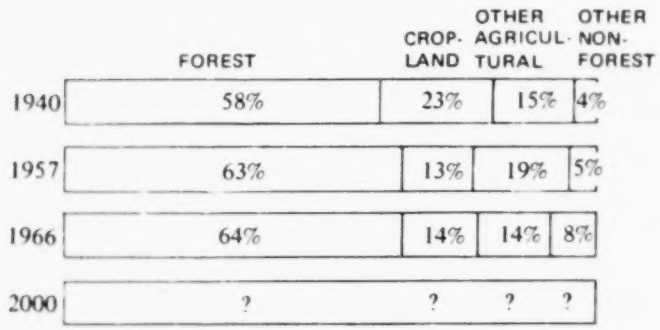
a. **Wood use trend**

A growing population requires more products. Population of the United States will be 310 million by the year 2000.



Annual paper consumption per person has increased from 58 pounds in 1900 to over 600 pounds in 1980. It is predicted that the per capita consumption may approach 900 pounds in the year 2000. Based on the per capita paper use of 1980, the average newborn child who lives to old age will use nearly 20 tons of paper.

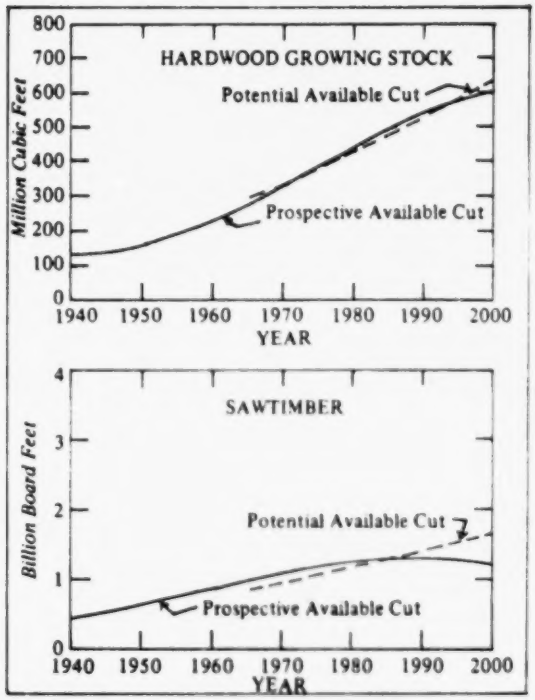
b. **Land use trend**



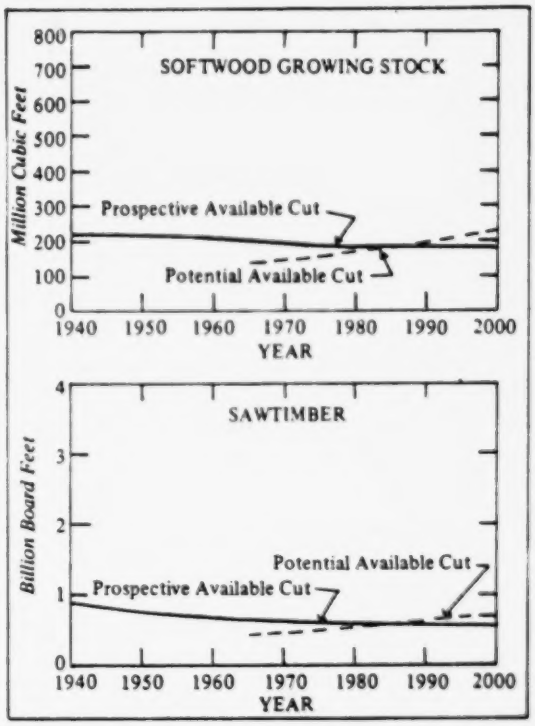
II. E. 4. c. **Virginia's timber supply outlook**

The following charts show the prospective volume of timber that will be available if the current trend in forest management continues, compared to the potential volume of timber that would be available if maximum timber production could be obtained from Virginia's forest land.

Prospective and Potential Available Cut, Virginia, 1976-2006



Prospective and potential available cut, hardwood, 1965-2000, Virginia.



Prospective and potential available cut, softwood, 1965-2000, Virginia.

Unit 2— Understanding How Trees Grow

TASK ANALYSIS:

Performance Objectives

1. Given a pictorial diagram of a tree, identify the parts of the tree and explain the function of each part with 100 percent accuracy.
2. Given a written test on tree growth, demonstrate knowledge of how a tree grows in both height and diameter by answering eight out of ten questions correctly.

Enabling Objectives

1. Name the three main parts of a tree.
2. Explain the process of photosynthesis.
3. Define the term transpiration.
4. Explain how a tree forms annual rings.
5. State the difference between terminal buds and lateral buds.
6. Explain why leaves change color in the fall.

Criterion-Referenced Measures

1. Identify the parts of a tree and explain the function of each part with 100 percent accuracy.
2. Explain how a tree grows in both height and diameter by answering eight out of ten questions correctly on an instructor-prepared test.

Selected Instructional Activities

1. Display a cross-section of a tree trunk and have students identify the outer bark, inner bark, cambium, sapwood, and heartwood; point out the annual rings and have students determine the age of the tree when it was cut.
2. Have students bring a samples of terminal buds and lateral buds to use during discussion of height growth of trees.
3. Have students collect leaves and make a bulletin board display illustrating why leaves change color in the fall.
4. Show filmstrips to introduce the process of photosynthesis.
5. Arrange a field trip to a timber-cutting site and have students determine the age and growth rate of selected trees.

Selected Tools and Materials

Cross-section of tree trunk
Pictorial diagram of a tree
Bulletin board materials
Instructor-prepared test on tree growth
Projector (filmstrip) and screen

Selected Audiovisual Materials

Filmstrip: How Trees Grow. Filmstrip No. 2, Virginia Forest Series (#01750). Audiovisual Services, Virginia Department of Education.
Filmstrip: How Trees Live (#08109). Audiovisual Services.
Chart: How a Tree Grows. USDA, Forest Service.
Chart: The Tree and the Soil. USDA, Forest Service.

Selected References

Forestry in Virginia. VPI Agricultural Extension Service Bulletin 223.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. Why are trees important to us other than for the products they furnish? (They hold the soil, increase its fertility; moderate temperature; create beauty, etc.)
2. Why is it important to understand how a tree grows? (A crop cannot be properly managed and grown unless its growth requirements are understood.)

B. General situation

Few people understand that a tree is not only a living plant, but that trees are necessary for our very existence. Few people know the different parts of a tree and how these parts function to make an efficient, living organism.

C. Local situation

Questions such as those listed below should be used to determine students' knowledge of tree growth.

1. What are the parts of a tree?
2. How does a tree increase in height?
3. How does a tree increase in diameter?
4. Why do leaves change color in fall?

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

Take students on a field trip to an area where timber is being cut. Have students participate in the following activities.

1. Determine age of trees cut by making annual ring counts on the stumps.
2. Determine average height growth of a tree by counting rings on the stump and then the number of rings at each cut up the tree trunk. The difference in ring counts between any two points, divided into the distance between these points, will give the average height growth per year.

   Example: Number of rings at stump = 25
   (minus) Number of rings at 5 feet = 22
   3

   $5 \div 3 = 1.66$ feet average growth per year

3. Use an increment borer to determine age and growth per year. Bore tree at 4-1/2 feet from the ground (diameter breast high), count the rings, and add 4 to determine the age of the tree. (This is necessary since it probably took the tree four years to reach this height.)

4. Count 10 rings in from the bark edge, and measure the width of the wood making up these 10 rings. This is the radial growth. To determine the diameter growth over the last 10-year period, double this figure.

   Example: 10 rings measure 1-1/2 inches
   2 x 1-1/2 = 3 inches diameter growth in 10 years.

IV. EVALUATION

A. Give each student a pictorial diagram of a tree to point out the various tree parts and explain their functions (100 percent accuracy).

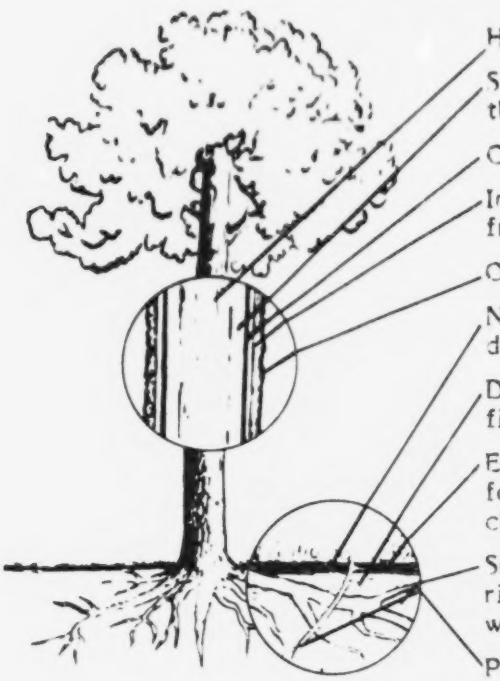
B. Have students complete a short test on tree growth (80 percent accuracy) or complete the activities noted under APPLICATION.

HOW TREES GROW

II. PRESENTATION

A. What is a tree?

A tree is a woody plant having one well defined erect perennial stem and a more or less definitely formed crown, attaining a diameter of at least 8 inches and usually attaining a height of at least 12 feet. Follow the chart below during explanation of the parts of a tree and their functions.



Heartwood (inactive) gives strength.

Sapwood (xylem) carries water and nutrients up the stem.

Cambium is where diameter growth occurs.

Inner back (phloem) carries manufactured food from leaves to branches, trunk, and roots.

Outer bark provides protection.

Natural mulch of leaves protects surface against drying and erosion.

Decomposing layer (humus) is inhabited by beneficial insects, bacteria and fungi.

Enriched soil layer is source of much of tree's food; it is the home of earthworms which leave channels for water and air.

Subsoil contains soil particles and parent material. Deep roots find their home here and absorb water and anchor tree.

Passages through soil are constructed by insects.

The three main parts of a tree are the roots, trunk, and crown.

1. **Roots**

   The roots of a tree have three main functions:

   a. They anchor the tree.
   b. They absorb water and dissolved nutrients.
   c. They protect against erosion.

2. **Trunk**

   The trunk supports the crown and produces useful wood. The trunk is made up of the following:

   a. The outer bark protects the tree from injuries and heat or cold, just as skin protects the human body.
   b. The inner bark (phloem) carries manufactured foods made in the leaves down to the branches, trunk, and roots.
   c. The cambium consists of a layer of cells where growth in diameter occurs. It forms annual rings of new wood inside and new bark outside.
   d. The sapwood (xylem) carries water and nutrients from roots to leaves.
   e. The heartwood was once sapwood, but is now inactive. It gives mechanical strength to tree.
   f. The annual rings are made up of springwood and summerwood.

II. A. 3. **Crown**

The crown is the leaf area of the tree, including the branches which support the leaves. Size and shape are affected by environment and genetics.

a. **Leaves**

Leaves are the most important chemical factories in the world. Their manufacturing process is called photosynthesis. Without this process there would be no food for people or animals, no wood for shelter, no humus for the soil, no coal for fuel. Every living thing depends on this process.

(1) **Photosynthesis** (from photo, meaning light, and synthesis, meaning putting together)

(a) Inside each leaf, millions of green-colored, microscopic "synthetic chemists" (chloroplasts) manufacture sugar. They trap radiant energy from sunlight for power. Their raw materials are carbon dioxide from the air and water from the soil. Oxygen, a byproduct, is released. This fundamental energy-storing, sugar-making process is called photosynthesis--the chemical formula is chlorophyll + CO_2 + H_2O + Sunlight = $C_6H_{12}O_6$ + O_2 (oxygen).

(b) What happens to this leaf-made sugar in a tree? With the aid of "chemical specialists" (enzymes), every living cell, from root tips to crown top, goes to work on the sugar. New products result. Each enzyme does a certain job, working with split-second timing and in harmony with the others. In general, enzymes break down sugar and recombine it with nitrogen and minerals to form other substances.

(c) Enzymes change some sugar to other foods, such as starches, fats, oils, and proteins, which help form fruits, nuts, and seeds.

(d) Enzymes also convert some sugar to cell-wall substances, such as cellulose, wood, and bark, and make some of the sugar into other substances which find special uses in industry. Some of these are rosin and turpentine from southern pines; syrup from maples; chewing gum from chicle trees and spruces; and tannin from hemlocks, oaks, and chestnuts.

(2) **Transpiration**

Transpiration is the release of water-vapor from living plants. Most of it occurs through the pores (stomates) on the underside of the leaves. Air also passes in and out. Factors which affect transpiration are relative humidity, temperature, sunlight, wind, available water, and atmospheric pressure.

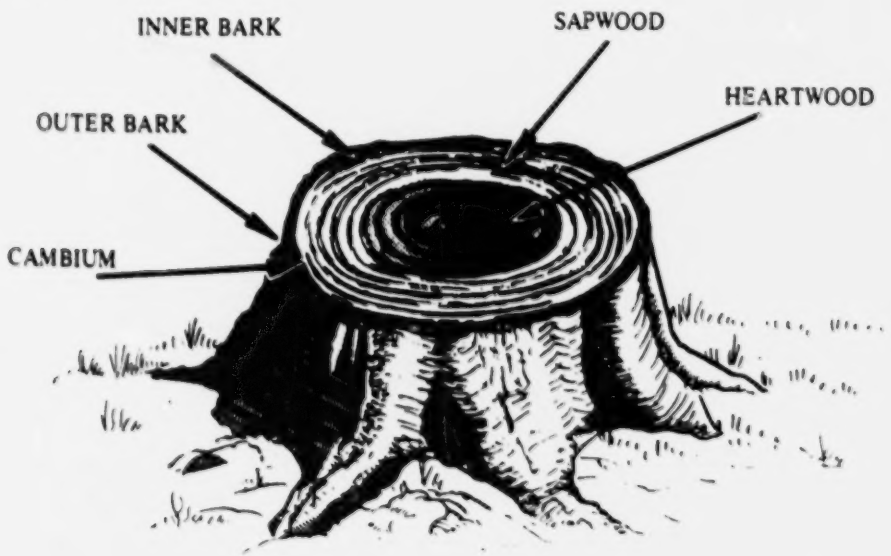
II. A. 3. b. **Branches**

Branches anchor and conduct fluids to the tree's leaves and flowers.

c. **Flowers**

Flowers function as the reproductive organs of the tree.

B. **How does the tree grow?**



1. **Diameter growth**

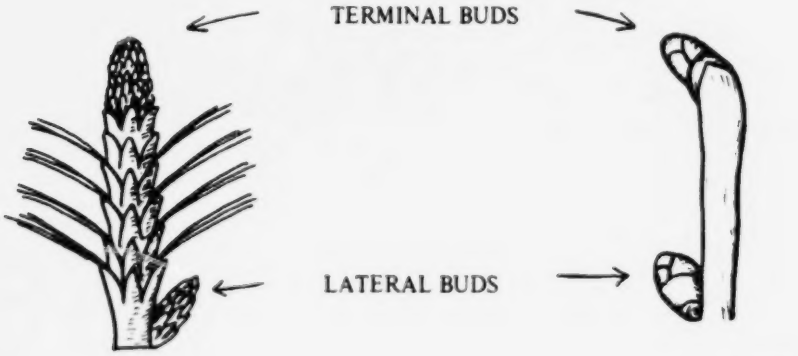
The diameter of a tree increases as cambium layer forms new wood cells on the inside and bark cells on the outside. Alternate growth of spring and summerwood forms annual rings. The cambium is a single layer of cells that retains the capacity to divide throughout the life of the tree.

a. Cambium gives origin to both wood and bark.
b. When cambium becomes active in spring, it begins to split off rows of wood cells to the inside and rows of bark cells to the outside.
c. Wood formed in spring consists of light-colored, thin-walled cells; later in season the cells formed are smaller, darker, and have heavier walls (summerwood).
d. Alternation of spring and summerwood causes annual rings.
e. When growth conditions are favorable and food and water abundant, the rings are wide. Under unfavorable conditions, such as drought, the rings are narrow.
f. By counting the annual rings, one can determine the age of a tree.

II. B. 2. **Height growth**

Elongation from terminal buds produces height growth (the same is true of twigs and branches).

a. Terminal buds complete growth early in the season, usually by the end of June.
b. In many trees, all cell division for the next year's growth is completed in the bud by this time.
c. The next season's growth takes place mostly by elongation of the bud cells formed in the previous year.
d. Twigs and branches are formed from lateral buds.



C. **Why do leaves change color?**

A green leaf is green because of pigments known as chlorophyll. This green color masks out the colors of the other pigments. During the growing season, the plant replenishes the chlorophyll as it is used. As autumn approaches, chlorophyll is replaced at a slower rate. This is when the green masking dwindles and the other pigments begin to show.

1. **Anthocyanins**

This groups of pigments causes the red and purple colors.

2. **Carotenoids**

(a) This group of pigments causes the yellow, brown, and orange colors.
(b) These pigments exist in many living things, giving characteristic color to carrots, corn, canaries, bananas, and egg yolks.

3. **Factors affecting leaf color**

Leaf color can be affected by light (overcast or sunny periods), temperature, moisture, nutrients, and other factors. This is a very complicated process, but basically the fall color change is the result of the nonreplenishing of green chlorophyll permitting the other dominating pigments to take over.

Unit 3— Identifying Trees

TASK ANALYSIS:

Performance Objective

Given appropriate references, a list of the common names of or identifying statements about trees native to Virginia, and pictures or samples of these trees, match the names with the pictures, samples, or statements with 80 percent accuracy.

Enabling Objectives

1. Explain the importance of scientific names of trees.
2. Identify the parts of a leaf.
3. Define sinus, vein, petiole, dentate, serrate, and rachis.
4. Identify examples of trees having compound leaves; simple leaves; and leaves with entire margins, toothed margins, double-toothed margins, smooth lobes, and bristled lobes.
5. Identify examples of trees having flowers, nuts, and berries.
6. State the nine points of reference for tree identification.

Criterion-Referenced Measure

Match a list of names of trees common to Virginia with pictures, samples, or identifying statements with 80 percent accuracy.

Selected Instructional Activities

1. Have students create a picture dictionary correlating the common and scientific names of various trees.
2. Have students bring a list of all the trees contained in their own woodlots or in the school forestry area; have them bring specimens from trees they cannot identify.
3. Invite a local forester to speak to the class on ways trees may be identified.
4. Arrange a trip to a woodlot close to a stream. Have students identify all the trees they can and label representative ones along the trail.
5. Have each student assemble a leaf collection, concentrating on specific types of leaves.

Selected Tools and Materials

List of names (common and scientific) of trees common to Virginia
Pictures of or samples from trees
Projector (filmstrip) and screen

Selected Audiovisual Materials

Filmstrip: Identifying Trees. Filmstrip Nos. 3 and 4, Virginia Forest Series (#01750). Audiovisual Services, Virginia Department of Education.

Selected References

Field Guide to Trees and Shrubs. George Patrides.
Forest Trees of Virginia. Virginia Division of Forestry Publication 26.
Fruit Key and Twig Key to Trees and Shrubs. W. M. Harlow.
Patterns for Preservation--A Conservation Text, pp. 226-241. David Tillotson.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. In order to manage the forest properly, it is essential to recognize types of trees.
2. Since trees are common features of the landscape and since the products derived from them are indispensable to our way of life, it is desirable to have a general knowledge of at least the common commercial tree species and their uses.
3. The ability to identify trees gives us a better understanding of the world of nature and can add to our recreational enjoyment of the forest. Trees are important to wildlife and are essential elements in landscaping and beautification projects.

B. General situation

Most people have never learned how to identify the many kinds of trees in their own locality, and many apply the wrong names to the few trees with which they are familiar.

C. Local situation

On an informal field trip around the school yard or adjacent woodland, find out how many students know even the most prevalent trees.

1. Find out if they simply call them pines, oaks, and gums.
2. Determine the number of different kinds of trees in a given area.
3. Identify which of these trees are commercially important.
4. Have students look up a particular tree in the tree guide, then search for it.

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

Individual purposeful collections

1. Collect two (or three, if possible) different shapes of leaves from the same tree (sassafras, water oak, mulberry, etc.).
2. Collect two examples of simple leaves and two of compound leaves.
3. Collect a series of leaves exhibiting different margins, including entire, serrate or toothed, and dissected.
4. Collect leaves and cones of three kinds of pine.
5. Collect leaves and acorns of a typical red oak and a typical white oak and label points of difference.
6. Collect six distinctive twigs to observe bud characteristics (a winter project). Observe differences in size, color, shape, and arrangement (alternate and opposite).
7. Collect the leaves of white oak and post oak.
8. Collect, mount, and label the parts of a typical red oak leaf.
9. Collect leaves from 15 or 20 local hardwoods and at least 3 local conifers.

IV. EVALUATION

Tests on tree identification can take the form of a field trip, a written test, or an oral or written test using pictures of samples.

A. On a field trip, it is suggested that the trees be numbered, as in the Forestry competition.

B. For a written test, give students a list of the common names of trees and have them select answers for questions 1 through 5.

1. Name two trees having opposite branching.
2. Name two trees having compound leaves.
3. List 15 trees of the local area.
4. Name a tree having each of the following features:

a.	berry	h.	alternate twigs
b.	nut	i.	simple leaf
c.	drupe	j.	compound leaf
d.	entire margin	k.	winged fruit
e.	toothed margin	l.	swampy habitat
f.	dissected margin	m.	dry ridge habitat
g.	opposite twigs	n.	smooth bark

5. Name two trees with showy flowers.
6. Name the parts of a leaf.
7. Describe differences between fruits (walnut and hickory).

TREE IDENTIFICATION

II. PRESENTATION

A. Nomenclature

It is not the purpose here to go deeply into scientific names. However, it is important to understand that for many of our common trees there are a number of common names. Loblolly pine, for example, has over 25 common names in general use. Much confusion exists in the names yellow poplar and white poplar, given to the same species at different ages or when occupying different sites.

Each tree recognized as a distinct species has a scientific or Latin name which ultimately pins down its identification, for there can be only one tree with that scientific name. An excellent and thoroughly practical example of this is Virginia pine, which is often called spruce, spruce pine, scrub pine, Jersey pine, etc. Its scientific name is Pinus virginiana (named for Virginia) and it is known by this name throughout the world.

These scientific names serve also to show the relationship of many of the trees. For example, sweet gum and black gum might be thought to be related. Here the word "gum" is meaningless. Each tree species has a generic name and a record name; for example, all pines are given the generic name "Pinus" and another name which identifies the particular kind of pine. In the case of sweet gum and black gum trees, Liquidamber and Nyssa show this lack of relationship, for they represent two different genera.

Remember, although there are many local common names for the same species throughout the state or nation, there is a standard or scientific name that can be used to identify a given tree.

B. Identification features

The identification of a particular tree depends on both observation of the parts of the tree and the knowledge of the location or area in which the tree grows. Refer to Forest Trees of Virginia while studying the following identification procedures.

1. Leaves

Leaves offer a very simple means of identifying most trees. Unfortunately, this feature is not so useful in winter, although in some cases withered leaves might still persist to give a clue as to the identity of the trees. Then, too, a number of tree species have persistent green leaves throughout the winter (e.g., pines, spruces, hemlock, cedar, and holly).

a. Parts of a leaf

Refer to the diagram (Figure 3-1) which shows the essential parts of a leaf: midrib, margin, vein, petiole or stem, and base. These parts are often referred to in tree identification terminology.

II. B. 1. b. **Shape of leaf**

Shapes vary considerably from one species to another. In sassafras and water oak, there are considerable variations in the shapes of leaves found on the same tree. Refer to those species in the book Forest Trees of Virginia.

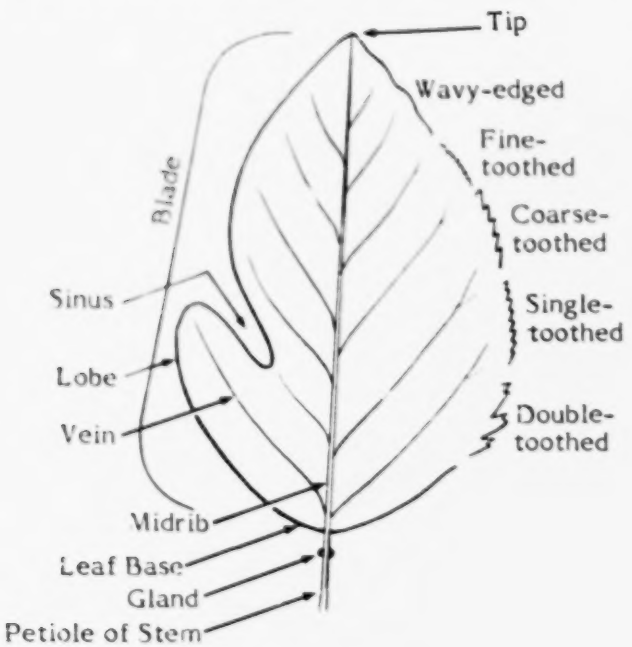
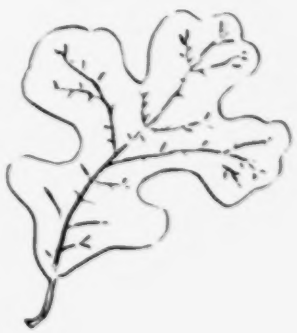


Figure 3-1. Parts of a Leaf

Some leaves are compound leaves; that is, they consist of a number of leaflets which together constitute the leaf. The stem is called a rachis. A good example of this is the leaf of the hickory, depicted below. Other trees having compound leaves are the walnut and the ashes, but most trees have simple leaves. In learning tree identification, care must be taken not to confuse an individual leaflet from a compound leaf with a simple leaf.

PIGNUT HICKORY
(Compound Leaf)



POST OAK
(Simple leaf)

Figure 3-2. Compound and Simple Leaves

II. B. 1. c. **Margins of leaf**

Various dissections of the margin of the leaf are quite valuable in establishing a tree's identity. Some have entire margins, as illustrated by the black gum. Others are toothed or dentate; a common example of this is the beech. (The word serrate, meaning saw-toothed, is often encountered in the identification books; this is just a refinement for the term toothed.) Certain trees have leaves with double toothing, such as the elm, in which there is a smaller tooth on each tooth.

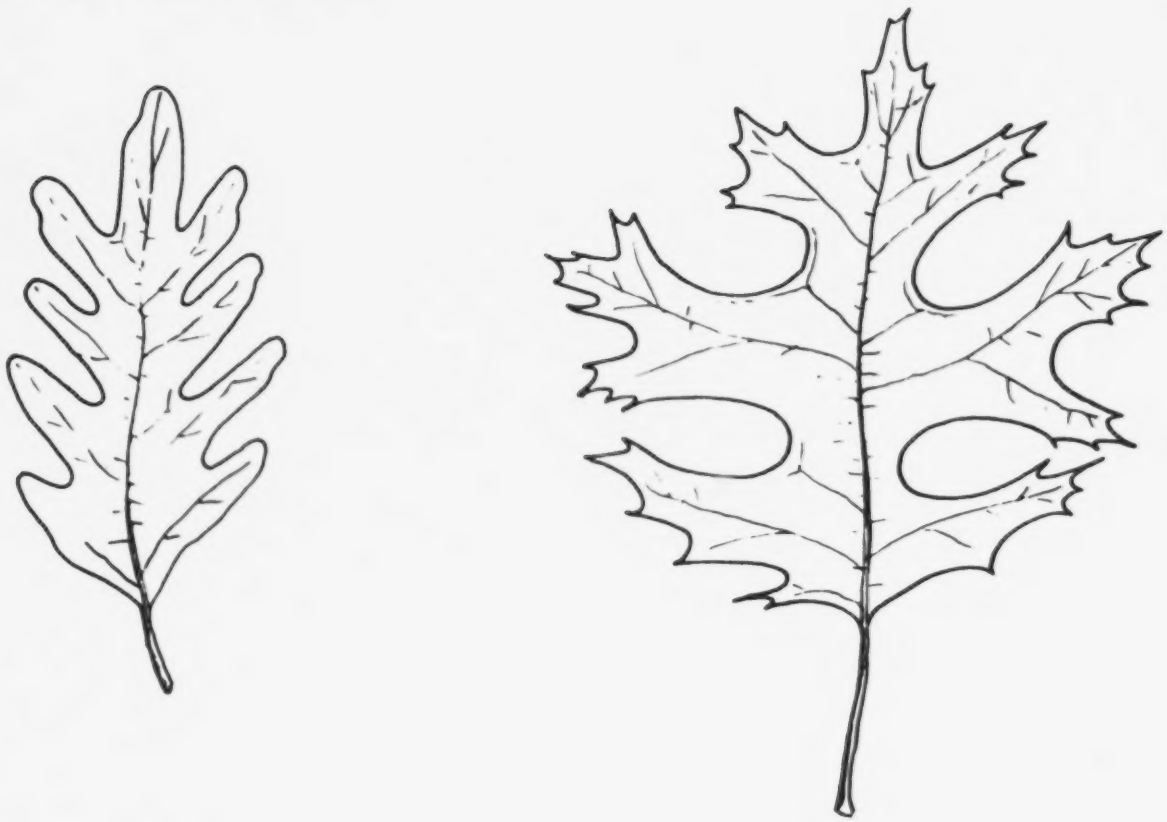
ENTIRE MARGIN (Black Gum) | TOOTHED MARGIN (Beech) | DOUBLE TOOTHED MARGIN (Elm)

Figure 3-3. Margins of Leaves

Dissected margins are most frequently found among the oaks. It is important to note that the oaks can be quite conveniently grouped into the red oaks and the white oaks, on the basis of the dissection. In the red oak group, the lobes are pointed and tipped with bristles. In the white oak group, the lobes are rounded and do not have bristles. See Figure 3-4.

The deep indentations are referred to as sinuses, while the finger-like projections are called lobes.

H. B. 1. c. (Continued)



SMOOTH LOBES
(White Oak Group)

BRISTLED LOBES
(Red Oak Group)

Figure 3-4. Dissected Margins of Oak Leaves

d. **Size of leaf**

Size is often important for identification, especially when using a tree book; for example, in Forest Trees of Virginia the normal leaves of winged elm are said to be 4 to 6 inches in length, the needles of loblolly pine are 6 to 9 inches long, and those of shortleaf pine are only 3 to 5 inches long.

e. **Color of leaves**

Color is a very useful identification tool in the fall, but even in spring and summer some leaves are of a much paler green than others.

f. **Pubescence of leaves**

Sometimes the fuzziness is on the under surface and sometimes only along the midrib. For example, the black oak is fuzzy along the midrib, whereas the northern red oak is quite smooth throughout.

g. **Arrangement of leaves**

In white pine five needles occur in a bundle; in loblolly pine there are three in a bundle; in Virginia pine the needles occur in twos. In shortleaf pine, the needles might occur in twos and threes.

II. B. 1. h. **Avoidance of error in leaf identification**

(1) Collect several leaves in order to get typical foliage. The leaves from farther up in the tree may look a little more like those shown in most books.

(2) Avoid sprout growth. These leaves are often distorted beyond recognizable shape or size, owing to the more vigorous growth of sprouts during their early years.

(3) Avoid collecting just leaflets of compound leaves.

2. **Flowers**

At certain times of the year, showy flowers of such trees as yellow poplar, magnolia, and dogwood can be used as means of identification.

Most tree species are wind-pollinated and have no need for showy flowers. However, flowers are of the utmost importance in the classification of all plants. For instance, the oak, beech, and chestnut are all placed in the family Fagaceae because of the close similarity of the flowers.

3. **Fruits**

Trees are often identified by means of the fruit they bear.

a. **Nuts**

Nuts are useful in pinpointing identification. For example, compare pictures of the nuts of white hickory with those of pignut hickory in Forest Trees of Virginia.

Observe also a basic difference between walnut and hickory as shown in Figure 3-5. In the hickories the husk breaks up by means of distinct division (called dehisence). It is interesting to note that pecan is really just another member of the hickories. Other important nut-bearing trees are the beech and the chestnut.

b. **Berries and drupes**

(1) Berries consist of seeds scattered throughout soft fleshy substance. An example is the persimmon.

(2) Drupes have an outer portion (a fleshy, bony layer) surrounding pit or seed. Examples are black gum and cherry. The blackberry is also a collection of druplets.

c. **Winged fruits (samaras)**

These fruits are one-seeded and usually do not split open. Examples are white ash, red maple, sugar maple, and yellow poplar, as shown in Figure 3-6.

d. **Cones**

Variations of cones in size, shape, and arrangement on the tree are quite useful in identifying the conifers (softwoods). Spruce cones hang downward, while those of balsam fir are erect.

e. **Other fruits**

(1) Pods are found on the black locust, honey locust, and redbud trees.

(2) Tufted seeds are found on the sycamore (after the balls break up).

e. **Other fruit characteristics**

(1) Winter persistence is sometimes useful for identification. Examples of trees with fruits in the winter are the sourwood, sycamore, sweet gum, and holly.

(2) Seed dissemination method gives useful clues as to the identity of trees or groups of trees. Each tree has a particular way of getting its seeds scattered. Seed dissemination is covered in more detail in a later unit.

HICKORY BLACK WALNUT

Figure 3-5. Examples of Nut-Bearing Trees

YELLOW POPLAR ASH MAPLE

Figure 3-6. Examples of Winged Fruits

II. B. 4. **Twigs**

a. **Arrangement**

Alternate and opposite twigs are useful identifiers. Maple, ash, and dogwood have opposite twigs and branches. This is easily remembered by the key word MAD, the letters of which stand for maple, ash and dogwood.

b. **Character of buds and leaf scars**

This is often a useful winter characteristic; compare beech with white ash, for example.

(1) Some tree buds are hairy, while those of other trees are smooth.

(2) Color variations are often useful--red maple, for example.

5. **Bark**

The identifying characteristics of bark, while difficult to describe, are useful:

a. **Relative smoothness**

The bark of beech is quite smooth, while that of white oak is rough.

b. **Color**

Sycamore bark has a variegated color pattern; in the persimmon, the bark is blackish.

c. **Other individual tree characteristics**

The warty appearance of hackberry bark is quite characteristic and distinctive. The resin spots or dimple-like depressions in the bark of shortleaf pine are quite useful for identification.

d. **General features**

Changes of color and general smoothness of bark are results of age. A good example is shown in loblolly pine. In young trees the bark is dark and quite rough. As the trees mature, the bark becomes rather smooth (slick bark) and acquires a reddish color.

6. **General characteristics of trees**

a. **Normal shapes of crown and branching habit**

A good example of branching habit is exhibited by black gum, wherein the branches grow straight out from the tree. Elms often have the general effect of an inverted cone and can be identified at a distance.

b. **Persistence of dead branches**

This is a useful feature when identifying scarlet oak.

c. **Buttressing or swelling of lower trunk**

This is characteristic of swamp species such as tupelo gum and bald cypress.

7. **Habitat**

a. **Universal trees**

Some trees, such as white oak and black gum, occur in a wide variety of situations.

II. B. 7. b. **Topographic features**

Most trees occurring in swamps and other wet lands are seldom found anywhere else. Trees of dry upland ridges cannot survive in swamps. Pin oak, for example, is a species of the wet bottomlands, while scarlet oak is a tree of the upland dry ridges.

c. **Nature of the soil quality**

Black walnut and yellow poplar of any size are usually found only on good soil; Blackjack oak and certain pines occur on poor or impoverished soil. Shortleaf pine and Virginia pine generally occur on dry soil; loblolly pine tends to thrive best on the moister soils.

8. **Range**

a. **General**

Yellow birch occurs in the mountainous part of the state; river birch occurs in the lower, swampier areas; red spruce is found only on the highest mountains; and cypress is found only in the swamps of the eastern part of the state. Many tree books have range maps showing the extent of the various trees. These are often quite accurate but are not absolutely reliable, especially along stream courses or places where there are slight climatic and topographic variations.

b. **Limits**

Tree ranges are limited by soil and climate, and particularly the delicate climatic conditions existing at time of pollination. For example, loblolly pine grows well when planted west of its natural range, but it does not produce seed.

9. **Other identification features**

a. **Hybrids**

A number of our trees freely hybridize. This is particularly true of the oaks.

b. **Exotics**

In the eastern part of the state, which has been settled longer, numerous exotics have been introduced. Many of these have reproduced themselves and their progenies are often found in normal forest areas at some distance from towns or dwellings. Examples of these are Princess tree (paulownia tomentosa) and Tree-of-Heaven (Ailanthus altissima), both of which were introduced from Asia.

Unit 4—Viewing the Forest as a Community (Ecology)

TASK ANALYSIS:

Performance Objective

1. Given instructor-prepared guidelines and research materials, write a two- to three-page paper on the influence of climatic, physiographic, and biological factors on the forest. Report must be rated acceptable according to the guidelines provided and accurate according to research references.
2. Given art supplies and appropriate references, create a poster or chart illustrating the progress of vegetation in Virginia from an old abandoned field to the climax forest. Chart must be rated acceptable according to instructor-prepared checklist.
3. Given a written test on stand competition, demonstrate understanding of the factors and effects of competition, tolerance, and dominance by completing the test with 75 percent accuracy.

Enabling Objectives

1. Define ecology and state why the study of ecology is important to forest management.
2. Identify the site factors which influence the distribution and growth of trees or plants.
3. Explain how temperature, moisture, wind, sunlight, lightning, and heavy snow influence tree growth.
4. Define topography, altitudinal zonation, slope, and aspect.
5. Identify the soil factors which influence tree growth.
6. Identify the beneficial and adverse biological influences affecting growth of trees.
7. Identify examples of five types of seed dissemination.
8. Explain why a knowledge of plant succession is important to forest management.
9. Name the factors of competition for tree growth in the forest.
10. Define dominant, co-dominant, intermediate, and suppressed.
11. Identify the characteristics of even-aged and uneven-aged stands of trees.

Criterion-Referenced Measures

1. Write a two- to three-page paper on the influence of climatic, physiographic, and biological factors on the forest, to be rated acceptable according to instructor-prepared guidelines and accurate according to research references chosen.
2. Make a poster or chart illustrating the progress of vegetation in Virginia from an old abandoned field to the climax forest, to be rated acceptable according to instructor-prepared checklist.

4. Complete a written test on the factors of stand competition and their effects with 75 percent accuracy.

Suggested Instructional Activities

1. Discuss the forest types found in the local area and the kinds of soil on which they occur.
2. Discuss the influence of site factors such as climate, topography, soil, wildlife, insects, livestock, and tree diseases on tree growth and forest competition.
3. Illustrate the concept of plant succession with the use of appropriate diagrams.
4. Discuss the factors of stand competition (sunlight, growing space, soil moisture, and soil nutrients) and the effects of each on forest management.
5. Discuss the various methods of seed dissemination.
6. Assign various field observation projects to individuals or groups of students to illustrate plant succession and stand competition.

Selected Tools and Materials

Instructor-provided research guidelines
Art supplies
Instructor-prepared test on stand competition
Diagrams illustrating plant succession
Projector (filmstrip) and screen

Selected Audiovisual Materials

Filmstrip: The Forest as a Community. Filmstrip No. 5, Virginia Forest Series (#01750). Audiovisual Services, Virginia Department of Education.

Selected References

Patterns for Preservation--A Conservation Text. David Tillotson.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. In order to manage the forest or wildlife area properly, it is essential to know something about the life of the forest and to regard it as a community of plants and animals.
2. An understanding of the nature of plant communities is useful in a number of ways, such as wildlife improvement, erosion control, fishing stream and pond improvement, and weed control.

B. General situation

Most people have a poor understanding of the forest growth process. In areas where the important tree species occur as even-aged forests, many people try to manage them as uneven-aged forests. Often they attempt to reproduce, manage, or plant trees on unsuitable areas, and have a very poor understanding of the quality of the site. Also, many people have no understanding of the natural process of plant succession.

C. Local situation

Begin with a discussion on the forest types found in the area and the kinds of soil on which they occur. Select the most important local forest type and determine what happens when it is cut. Outline the general bare land plant succession for the region and prepare or obtain appropriate diagrams.

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

The following field observation assignments are suggested as being helpful in viewing the forest as a community.

A. Seek out an old, abandoned field near home and try to find out the year in which it was abandoned. Describe the present vegetation. Also look for a place that has not been disturbed for around a hundred years; describe its vegetation.

B. Visit cutover forest lands and report present species. Try to date the cutting by determining the age of trees that have come up since cutting. Also, visit a forest fire area and determine what changes took place. Then visit a grazed and ungrazed hardwood forest and describe it.

C. Visit various vegetative types or situations and list the kinds of trees found in each. Critically examine the same timber type in a stream bottom and on a nearby ridge; measure the tree heights and ages.

D. Look over a marsh, swamp, upland ridge, bare rock area, rich hardwood soil, and an abandoned field, and describe the vegetation found in each.

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E. Visit a pine woods and bore trees of large and small diameters. What is the difference in age? Are vigorous young pines present or absent?

F. Visit a hardwood forest and report on the kinds of trees found in the undergrowth. What is the most abundant species there? Turn over a few old logs, notice the decay, and describe the animal life found there.

IV. EVALUATION

A. Distribute and discuss guidelines and references related to paper on the influence of climatic, physiographic, and biological factors on the forest. Evaluate according to report guidelines.

B. Prepare checklist to evaluate students' posters or charts illustrating vegetation progress from abandoned field to climax forest.

C. Prepare written quiz on stand competition (75 percent accuracy required).

D. Written or oral descriptions of field observations described in the APPLICATION section may replace items A-C; in this case, prepare checklist for evaluation of descriptions.

THE FOREST AS A COMMUNITY

II. PRESENTATION

A. Background information

As we begin the study of forestry, it soon becomes apparent that we must have a good understanding not only of trees and their growth, but of the forest or group of trees as a whole. Here we are concerned with the forest as a community of plants, and not merely as an assemblage of trees occurring in a disorderly assortment without any rhyme or reason. Until the forest or the specific timber stand is recognized as a living community, it cannot be managed intelligently. In other words, before we can make further progress in the application of forestry principles, we must realize that each forest unit is a result of several factors working together, factors over which we sometimes have little, if any, control. These are basically the environmental factors that influence or often preclude certain types of forest (plant) growth.

Under certain conditions, thriving forests can be expected; under other conditions, certain trees or plant species will be missing. Under still different sets of environmental conditions, there may be no forest as we conceive it, yet there may be a great assemblage of other plants (a prairie, for example, or a salt marsh, or a rock outcropping with an extremely thin soil). Every group of trees or plants has both optimum and minimum growing conditions. Some trees are adaptable to a wide range of environmental conditions, while others are quite limited to only the most suitable situations. We must attempt to understand these environmental factors and how they influence the growth and development of the forest community. This is the subject of ecology, the science that deals with the relations between plants and animals and their environment. The word ecology is by no means a formidable scientific term; it is derived from the Greek word eco, meaning home.

B. Site factors

What controls the distribution and best growth of trees or plants? Why are the forests and animals of Surry County different from those of Buchanan County? Why are the forests of eastern Virginia different from those of northern Maine? Site as used here is defined as "an area, considered as to its ecological factors with reference to capacity to produce growth or other vegetation; the combination of biologic, climate, and soil conditions of an area."

1. Climatic factors

a. Temperature

Mean annual, extremes, and duration of growing season influence the type of plant growth. In the far north the frozen soil prevents tree growth.

b. Moisture

In our area, moisture is usually in the form of rainfall. The amount of moisture causes deserts, short grass prairies, long grass prairies, etc. Some kinds of trees require little moisture, others must have plenty. Many plants have developed special adaptations to withstand drought, such as waxy, thick leaves and short, active growing season during periods of rainfall. Humidity is often important.

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II. A. 1. c. **Wind**

In high mountains, winds produce distorted growth or limit growth.

d. **Solar radiation**

The amount of sunlight influences tree growth.

e. **Other weather conditions**

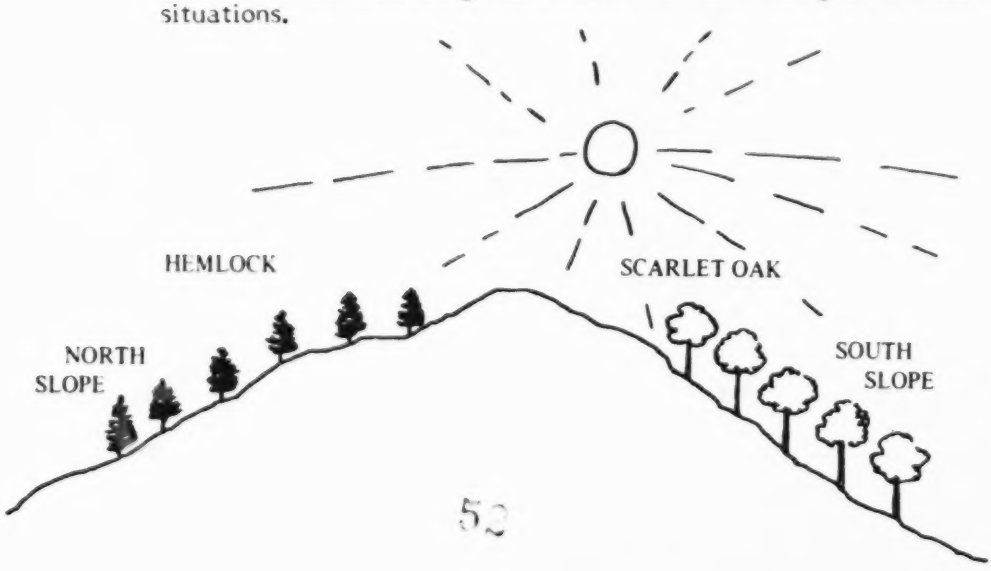
Lightning or heavy snow influence tree growth, mostly in very high mountains and in the far north. Some trees cannot resist snow and sleet damage--this limits northern colonization of southern trees.

2. **Physiographic factors**

a. **Topography**

Topography influences local climate and affects the type of soil and the degree of erosion. Two greatly different areas, the Dismal Swamp and Whitetop Mountain, owe their differences almost entirely to topography. To some extent there is an altitudinal zonation of plants. For example, Fraser fir and red spruce are trees found only in the highest mountains of the state.

Slope or aspect is of great importance in the mountains. In this sense the terms slope and aspect refer to the direction of exposure of the mountainside. Certain kinds of trees thrive and grow better on north slopes than on south slopes, and in the natural forest, north and south slopes will have quite different forest vegetation. As a general example, northern red oak might occur on the north slope, while chestnut and scarlet oak occupy the south slopes. Hemlock at low elevations is usually found only on north slopes, while at higher altitudes it is more universally distributed. Swamps and bottomlands are topographic features. The difference between them is that the swamp is subject to frequent prolonged inundations, and only trees that can tolerate great amounts of water can grow in such situations.



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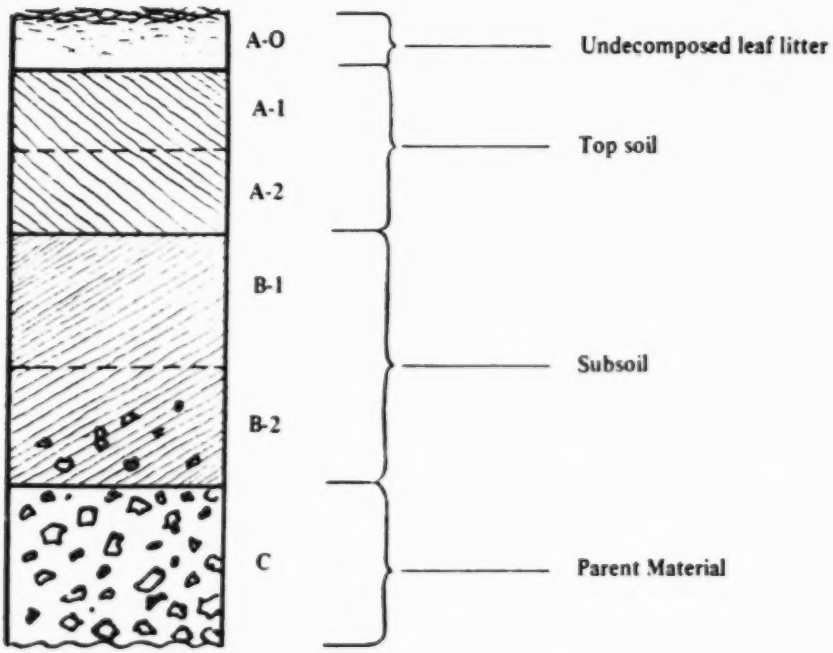
II. A. 2. b. **Soil factors**

A general agricultural knowledge of soils is essential to the understanding of forest ecology. The typical forest soil profile is that of undisturbed soil, and the soil has a definite layer of litter and duff. The following factors can affect the suitability of forest soils for various species of trees:

(1) Past human use, including forest fires
(2) Depth and texture of topsoil (water-retaining capacity)
(3) Nature of subsoil
(4) Leaching out of nutrients in certain soils
(5) Soil moisture conditions
(6) Soil acidity and alkalinity
(7) Organisms of the soil



Profile of a Typical Undisturbed Forest Soil

3. **Biological factors**

Certain animals and plants influence the site beneficially or adversely for tree growth:

a. **Beneficial influences**
(1) Insects that pollinate plants
(2) Soil organisms and organisms producing decay of leaves, logs, and roots
(3) Predators (hawks, owls, foxes, etc.) that control injurious rodents and seed consumers

II. B. 3. b. **Adverse influences**

(1) Grazing livestock
(2) Overpopulation of wildlife (rodents, deer, etc.) that destroy young trees
(3) Insects and tree diseases
(4) Plants, such as honeysuckle or kudzu, which strangle forest growth

4. **Determination of site**

Foresters determine the site quality of even-aged stands of timber by measuring the total height of the dominant trees and obtaining the age of the trees. The height attained at 50 years is called the site index of that soil for the particular species. If a red oak has reached 80 feet at 50 years, it is on site index 80, which is good for oak. If the trees are not 50 years old, the site is determined from a set of curves designed for each species. For example, if loblolly pine is 90 feet high at age 40, it is on site index 100, which is very good. If at 40 years it has only become 60 feet high, it is on site index 67--a poor site.

Indicator plants are often useful in judging loblolly pine sites. The presence of yellow popular trees in the pine woods indicates a good pine site. A heavy growth of lichens (reindeer moss) indicates a poor pine site.

C. **Seed dissemination**

The earth is constantly being supplied with all sorts of seeds, spores, and eggs. The plant kingdom has developed a number of interesting methods of seed dissemination, all for the purpose of regeneration and the colonization of new areas:

1. **Wind**

Certain seeds, such as winged seed (pine, yellow popular, ash, and maple) and tufted seed (thistle, dandelion, sycamore, and willow) are disseminated by the wind.

2. **Animals**

a. Fruits serve as a temptation or a bribe to an animal or bird to carry seed to a distant place.
b. Stick-tights, beggar lice, sheep burrs, etc., are clever means of dissemination through means of passing animals.

3. **Water**

Seeds of the swamp species (cypress, overcup oak, and tupelo) are often transported by water to distant areas.

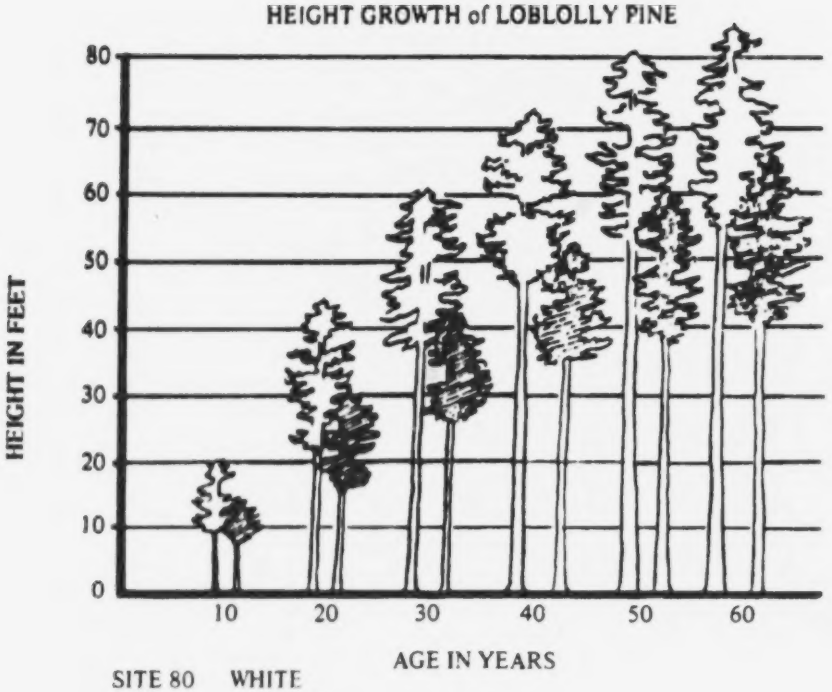
4. **Ejection**

Some seeds are, when ripe, violently ejected by specialized fibers in the pods. Some seed containers or capsules are designed like little salt shakers (seedbox, for example).

5. **Special adaptations**

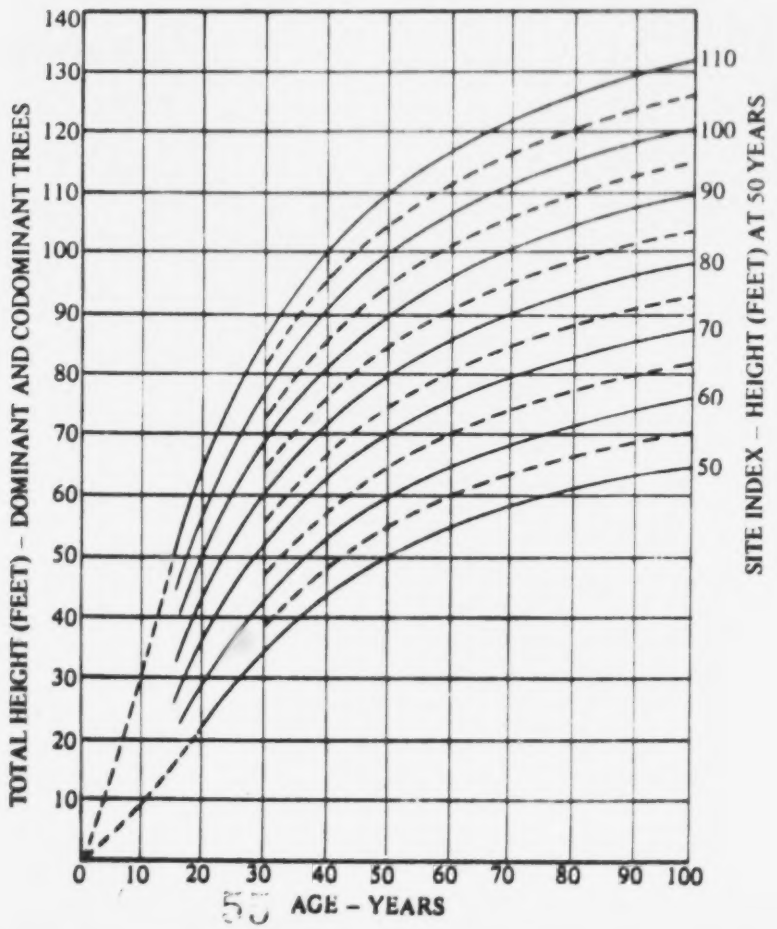
The seed of the mistletoe has a glue-like substance which enables it to stick to a tree when carried there by a bird.

HEIGHT GROWTH of LOBLOLLY PINE



SITE 80 WHITE
SITE 60 SHADED

SITE INDEX CURVES FOR LOBLOLLY PINE



II. C. 6. **Gravity**

Nuts and acorns can fall and roll to new places.

Only a small number of the seeds that are transported ever germinate and grow. Many of them are eaten by animals, birds, and insects; others fall in adverse situations or on the wrong soil. Of the millions that actually germinate, only a few survive to develop. For example, observe the mass of spores put forth by a puff ball fungus, or consider the millions of eggs laid by certain fishes or insects. Only a tiny fraction ever develop.

It should also be borne in mind that many plants can reproduce themselves vegetatively by sprouting, layering, and suckering.

D. **Plant succession**

There is no such thing as a permanently bare land area, at least in our region. A piece of land which becomes denuded by forest fire, land clearing, mining, rock slide, or sand dune encroachment does not stay bare for long. Almost immediately, life reinvades such areas in an orderly and progressive manner. The cleared field, upon its subsequent abandonment, is the most common bare area in this region, and everywhere we go we have ample opportunities to observe this process. Rock slides, sand dune encroachment, or mining operations represent an extreme situation; nevertheless, even these areas gradually become reclothed with vegetation that continually improves toward what is known as the climax.

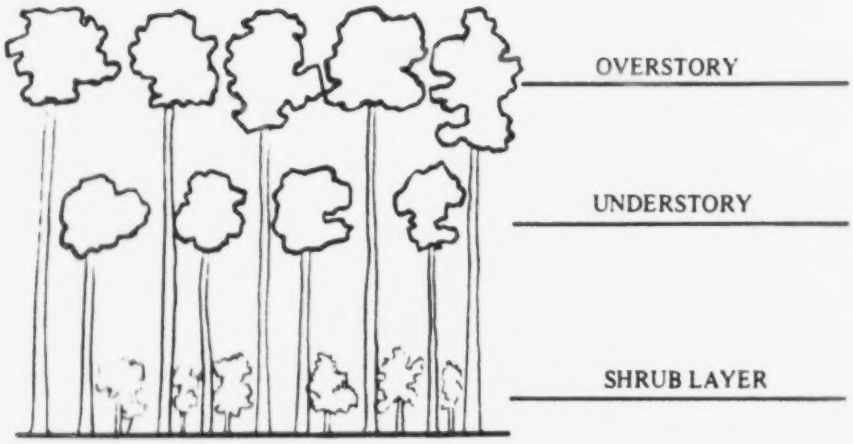
In the eastern Virginia uplands, this climax is a forest of oak, hickory, and beech. In some parts of the mountains, owing to climatic differences, the climax might be one of beech, sugar maple, and birch. All parts of the world have this characteristic climax vegetation--nature's final expression for that region. An area might never quite reach this climax, but the vegetation constantly aims toward it. In this unit, there is no need to go into the terminology needed to fully appreciate the full story of plant succession and its attendant animal succession.

Classic ecological examples of climax vegetation are to be found in the northern states where the retreating glacier left areas of denuded bare rock and thousands of gouged-out basins that became lakes and ponds. Now many thousand years later, this vast area is fully clothed in forest or prairie vegetation. Many of the lakes have silted full and are now part of the forest; other lakes are destined in time to become filled in.

The most outstanding example of this orderly progress of plant succession is the case of the Krakatoa Volcano in the East Indies, which on eruption in 1883 completely denuded adjacent areas of all life. The vegetation is back already, and the study of its development and progress has given the science of ecology a very rich example of the tendencies of natural vegetation to repossess a bare area in an orderly fashion.

The study of plant succession, therefore, should teach us that the vegetative units we observe from day to day, and perhaps take for granted, have arrived at whatever stage we observe in a well ordered and almost predestined manner. What at first appears to be a wild profusion of masses of vegetation will, on a second look, show us that the plants are arranged in definite sequences in relation to each other, to the animal life present, and to the environment. A forest area on good soil will be found to be stratified from top to bottom.

II. D. (Continued)



First in the stratification are the dominant trees, forming the canopy. The second layer consists of shade-enduring trees, of smaller stature but in place eventually to poke their way upward and become the dominant forest. In a pine forest the secondary layer might be of oak, hickory, or beech and other hardwoods. Below this second layer is a layer of shrubs adapted to withstand shade. Below these shrubs are the herbaceous plants of the forest (certain grasses, ferns, etc.), and under them are various mosses and lichens. In the soil other plant and animal organisms are found which relate to that condition or state of the forest's development.

With an appreciation of this orderliness and the progress of vegetation from bare soil to climax forest, we are ready to make a practical study of local and common plant succession, starting from an old abandoned field. (This is in reality called secondary succession, for the soil of the old field or burned area is receptive to the seeds that will bombard it.)

An example of normal upland abandoned field succession in most of Virginia would be as follows:

Year 1 following abandonment: Area is dominated by various weeds and grasses.

Year 2: There is gradual encroachment of other herbaceous plants, including the little white aster. A few pine seedlings might begin showing up.

Year 3: Broomsedge becomes dominant; more pine seedlings appear.

Year 5: Pine overtops the broomsedge and weeds.

Year 10: Pines form a rather dense, closed canopy; broomsedge and weeds disappear.

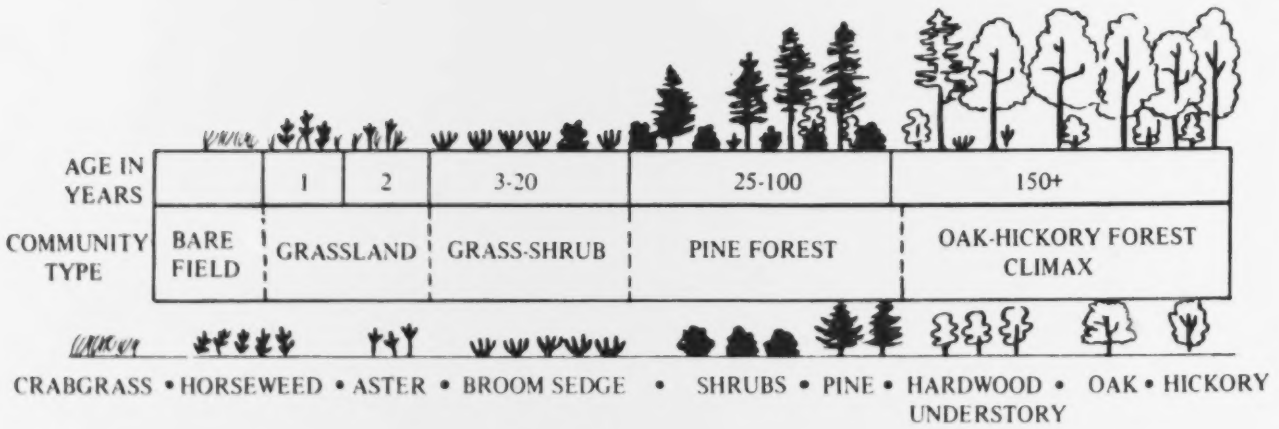
Year 20: A few hardwood seedlings begin showing up.

Year 40: The pine is middle-aged. A hardwood understory has developed--black gum, maple, sweetgum, and hickory.

II. D. (continued)

Year 80: Pine is overmature and the hardwood growth, now principally oak, hickory, and beech, is forging ahead and replaces any pines that might die out.

Year 150: The forest is now one of oak, hickory, and beech and is reproducing itself in its own shade. The pines have become little more than scattered relics. The climax has been reached. On poorer soil the time taken to reach the various stages would be much longer. Cutting of the larger pines when they have attained sawlog size merely hastens the process toward a hardwood forest.



Secondary Upland Succession in Southeastern United States, adapted from Fundamentals of Ecology

In modern forestry, following the cutting of pine timber or in converting cutover hardwood areas to pine, the forester can take advantage of fire as a means of reducing unwanted brush growth back to the bare field condition. This is called prescribed burning; and unlike wildfires, prescribed burnings are set under safe conditions and for the one purpose of properly starting a new forest of pine or the valuable hardwoods.

Prescribed burning is a very practical application of a knowledge of plant ecology in forest management.

E. **Stand competition**

In the whole realm of nature there is competition among plants (and animals too) for growing space, moisture, nutrients, food, etc. When this competition becomes really serious, the plants or animals that are poorly adapted to the particular environment quickly lose out in the struggle.

II. E. 1. **Factors of competition**

a. **Sunlight**

All trees require sunlight. Some require full sunlight; others can stand some shade. When one tree of the same species is able to grow taller than the next tree, it gets most of the sunlight and the other one gradually loses out. Young pine under hardwood does not receive full sunlight, and when the hardwoods are cut or killed, this form of competition is removed. If hardwoods were not cut or killed, the pine would, in time, die out.

b. **Growing space**

There is room for just so many trees or plants on a given area. In the case of trees, this number diminishes with increasing size or age. As a stand of young trees gets older, the trees get larger, make more demand on the soil, and have to develop as large a crown as possible. Only those trees that can get ample space will be able to get the necessary sunlight. It must be remembered, too, that the roots are in competition for space in the soil.

c. **Soil moisture**

Competition for soil moisture is often quite serious among trees. When all trees are competing for moisture, only the strongest will get an ample supply. When the hardwoods overtopping young pine are cut (and the stumps are poisoned), the pine roots are then able to get the moisture that would have been going to the hardwoods. Some kinds of trees require a great deal of moisture, while others require little. It must be remembered that all soil moisture is not always available to the tree. Some trees can take up more moisture from the soil than can others.

d. **Soil nutrients**

The nutrients in the soil are unavailable to the plants unless the soil moisture is there to carry them in solution. Thus soil moisture is the most important competition factor. However, some kinds of trees require more of a certain element (potassium) than others. If there is only so much available potassium in a soil, the potassium-demanding tree cannot compete with the tree that does not need as much.

2. **Effects of competition**

a. More adaptive trees are usually the ones that win out in the struggle. Poorly adapted trees often are unable to reproduce themselves as the situation changes. In other words, the trees of the area might gradually be replaced by trees that are more adapted to the slowly changing conditions.

b. Certain trees of the same species are, by inheritance, less vigorous and are quickly crowded out. For example, trees that are inheritably weak from the standpoint of height growth could easily be overtopped by better trees with good height growth possibilities.

II. E. 2. c. The different species all grow at slightly different rates and each makes a particular demand on the soil. Only certain mixtures of trees can grow together and really thrive, and these kinds of trees will dominate the others.

3. **Tolerance**

Tolerance is generally taken to mean the ability to withstand competition. Often this is reflected in the ability of certain kinds of trees to withstand shade. Such a tree is called a tolerant tree. Some trees, on the other hand, cannot stand shade, at least after they are several years old. These are called intolerant trees.

A good example is the comparison between beech and loblolly pine. Beech is tolerant of shade and we find young beech trees doing well under heavy shade. Loblolly pine cannot stand shade and we seldom find it growing under shade. All trees seem to be tolerant during the first four or five years of their lives; after that time, however, the intolerant species quickly die out.

General Tolerance Table for Common Virginia Trees

Tolerant--able to endure heavy shade

Hemlock	Red Maple
Beech	Black Gum
Sugar Maple	Basswood
Dogwood	Sourwood
Red Spruce	

Moderately Tolerant--able to endure some shade

Sweetgum	Northern Red Oak
White Pine	Southern Red Oak
White Oak	Yellow Birch
Hickory	White Cedar
Black Oak	American Elm
Sycamore	

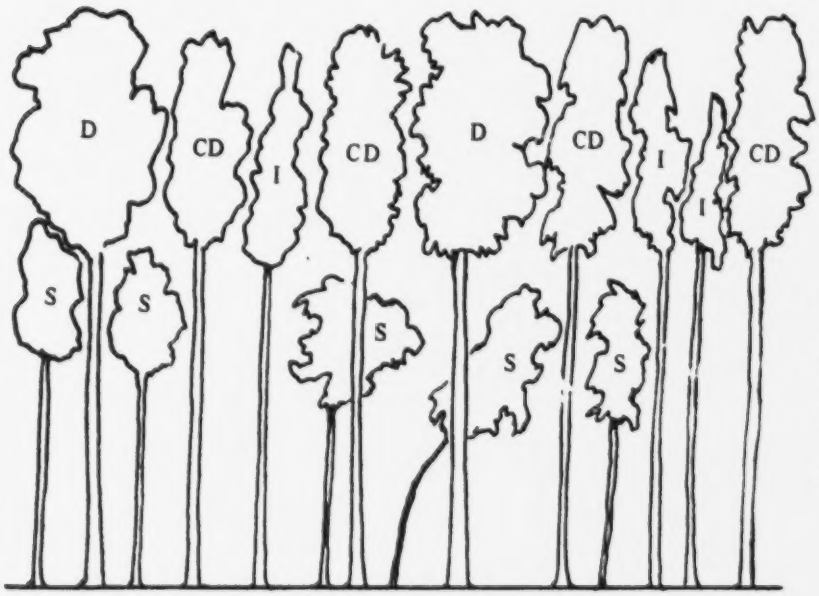
Intolerant--able to endure little or no shade

Loblolly Pine	Yellow Poplar
Shortleaf Pine	Cypress
Pitch Pine	Black Locust
Virginia Pine	Willow
Black Walnut	Eastern Cottonwood

(Adapted from Foundations of Silviculture)

II. D. 4. **Dominance**

As a result of the competition in even-aged stands, the better trees soon forge ahead of the others. These become known as dominants. Others in slightly less favorable position are called co-dominants. Below the co-dominants are the intermediates, which receive sunlight only from the top, and below these are the suppressed trees, or those below the general crown level.



Dominant, co-dominant, intermediate, and suppressed are technical forestry terms that are mentioned here only to emphasize that as a result of competition, the trees or plants rather quickly become segregated into classes as fewer and fewer of the better trees forge ahead and dominate the inferior ones of the same species.

It should be realized, too, that mixtures of different species growing at different rates will soon end up with the faster growing species as dominants, and unless the slower growing ones are tolerant of shade (competition), they will rapidly lose out in the struggle. Judgment must then be used in selecting species for mixed planting.

F. **Forest types**

1. **Definition**

A forest type is a community or association of certain kinds of trees. Some types are pure and others are mixtures. The following broad classes of timber can be considered as the important forest types of Virginia:

a. Pine
b. Pine-hardwood
c. Mixed hardwood
d. Bottomland hardwood
e. Swamp hardwood
f. Cove hardwood

II. F. 2. **Concept of types**

In considering the forest as a community, it is quite apparent that each community is dominated by a particular species or group of species. These species or species groups, present on a unit of area, are usually the result of the following:

a. Soil condition
b. Moisture relations
c. Past treatment
   (1) Logging of particular kinds of trees (converting a pine-hardwood to a mixed hardwood)
   (2) Clearing and later abandonment
   (3) Grazing, including wildlife influences
   (4) Forest fire
   (5) Draining or flooding
   (6) Eliminating or reducing certain tree species by insects and diseases

3. **Use of types**

a. As units for organizing the forest for management
b. As basis for timber estimates and valuations
c. As units for various cultural activities
d. As cutting areas in carrying out the forest management plan

All forest management practices should be considered in terms of forest types, using the type as the unit of treatment. It is possible to change the types; for example, if a mixed hardwood type is cut over and planted to pine, it becomes a pine type. If a pine-type forest is clearcut, without cultural work, it could easily revert to a mixed hardwood type.

G. **Even-aged and uneven-aged stands**

From the discussion of plant succession, tolerance, and competition, it should now be obvious that we cannot manage a forest unless we have some understanding of these terms. In agriculture we must understand the nature of a crop before we can produce it. We plant certain crops on certain soils and prescribe programs of cultivation accordingly. The forest is managed similarly.

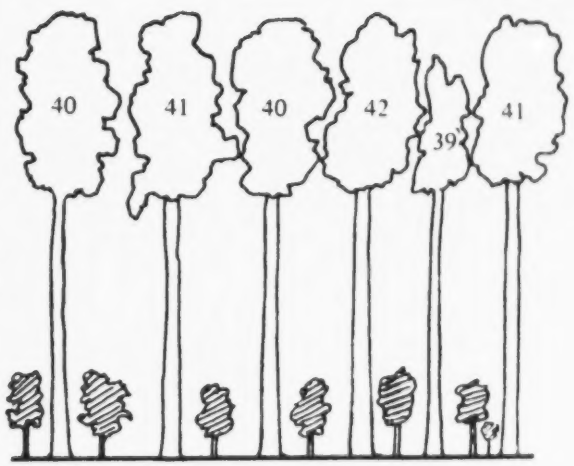
One of the essentials of timberland management is to distinguish between even-aged and uneven-aged stands and manage accordingly. Most of our really productive forests are even-aged in character. That is, all of the trees are essentially of the same age. A stand of pine originating on an old field is even-aged because the seedlings all germinated during the same few years. Later arrivals perished in the competition because they were not tolerant. In such a forest we often find trees with various diameters, the result of competition, not of difference in age. The increment borer, or a count of stump rings in a cutting, quickly proves this. If the trees were all different ages, they would be different heights, and an intolerant species like pine or yellow poplar could not thrive under the overhead shade of the so-called older trees.

II. G. 1. **Characteristics of the even-aged forest**

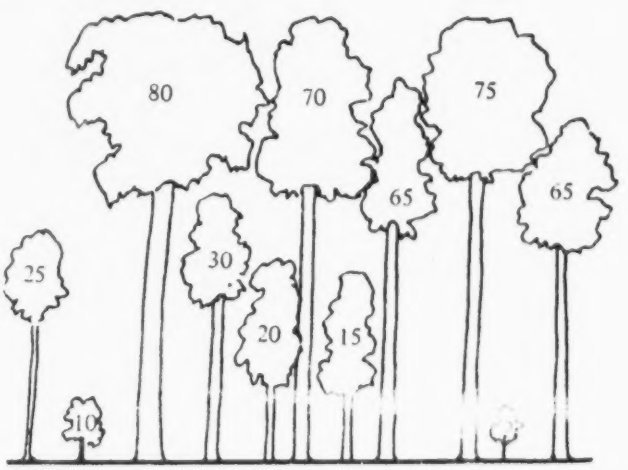
a. All trees of the same general age (within ten years)
b. Understory of different, usually tolerant species
c. Composed of trees of same general height growth characteristics
d. Tend to be pure stands, or composed of relatively few species
e. Tree components generally intolerant.

2. **Characteristics of the uneven-aged forest**

a. Theoretically, trees of all ages, often found in even-aged patches
b. Understory often same species as overstory
c. Considerable variation in height-growth characteristics
d. Most tree components tolerant, generally capable of reproducing in their own shade.



EVEN-AGED



UNEVEN-AGED

SHADE TOLERANT

NO. IN CROWN REFERS TO TREE AGE

Unit 5—Reading and Interpreting Maps and Aerial Photographs

TASK ANALYSIS:

Performance Objective

Given a U.S. Geological Survey quadrangle sheet of the local area, interpret the map symbols, legend information, and the representations of elevation and relief with 90 percent accuracy.

Enabling Objectives

1. Identify two types of maps and explain the major differences between the two types.
2. Define prime meridian, latitude, and longitude.
3. Explain how latitudes and longitudes are numbered.
4. Explain how maps are scaled.
5. Define true north, direction, azimuth, magnetic north, magnetic pole, geographical pole, and bearings.
6. Define elevation and relief and explain how they are represented on maps.
7. State four uses of topographic maps.
8. Identify the importance of aerial photographs in map preparation.
9. Explain how aerial photographs are scaled.
10. Identify uses of aerial photographs.

Criterion-Referenced Measure

Interpret the map symbols, legend information, and the representations of elevation and relief on a U.S. Geological Survey map of the local area with 90 percent accuracy.

Instructional Activities

1. Display examples of planimetric and topographical maps and discuss the purpose and uses of each type.
2. Determine if there are students in the class who live on farmland for which no map exists. Discuss the following questions for such cases:
   a. How could this land be located from a verbal or legal description?
   b. How can the acreage of the farm be estimated?
   c. What methods can be used to locate the best place for a main road or new power line right-of-way to a specific location on such a farm?
3. Present examples of cases in which maps were used or could have been used to prevent misunderstandings or financial loss.
4. Have students practice locating assigned locations on topographic maps.
5. Display examples of aerial photographs and compare them with corresponding maps. Have students identify objects in aerial photographs.

Selected Tools and Materials

U.S. Geological Survey quadrangle sheets of the local area
USDA aerial photographs of local area (1:20,000 contact prints)
Pocket sterioscopes
Masking tape
Engineer's scale or ruler with 0.1-inch divisions
Projector and screen

Selected Audiovisual Materials

Film: Highways in the Sky. U.S. Air Force.
Film: Introduction to Map Projections. United World Films, Inc.
Film: Topographic Mapping by Photogrammetric Methods. U.S. Geological Survey.

Selected References

Elementary Topography and Map Reading. Samuel L. Greitzer.
Forestry Handbook. Society of American Foresters.
Manual of Photographic Interpretation. American Society of Photogrammetry.
Map Reading and Topographical Sketching. Edwin R. Stuart.
Photogrammetry and Photo-Interpretation. Stephen H. Spurr.
Topographic Maps. U.S. Geological Survey.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. Maps are very important in our daily lives. They are used in the study of history, geography, economics, and many other special study areas. Road maps are perhaps the most familiar to us, but with a little knowledge and training, we should be able to use topographic maps and aerial photographs just as effectively.
2. To use maps efficiently for locating and describing physical and topographical elements of the terrain, a basic knowledge of map features, map symbology, and principles of interpretation is needed.
3. Aerial photographs are used to construct topographic maps and to keep the map information up-to-date. The best conditions for evaluating and interpreting terrain will be obtained if the interpreter has both a good topographic map and recent aerial photographs.
4. Aerial photographs allow the user to see, with a "bird's-eye-view," the lay of the land and physical features of the earth clearly. They can be used to supplement and clarify topographic maps.
5. A person can become quite familiar with a particular area of land and never actually "see" it as part of its surroundings.

B. General situation

1. Land is often bought and sold without reference to its actual location on maps or aerial photographs.
2. Boundary lines, roads, fences, and right-of-ways are often mislocated or even "lost," which may result in court cases and ill feelings between neighbors.
3. Forest products are sold with written contracts; however, the description of the land from which it is to be removed is given verbally, and its exact location may be in error.
4. The proper use of maps and aerial photographs can increase the efficiency and ability of land appraisers, contractors, and engineers.
5. There are many job opportunities available in the wood-using industry for people skilled in the interpretation and proper use of maps and aerial photographs.

C. Local situation

1. Determine the following information from students:
   a. How many live on a farm or own land for which they do not have a map?
   b. How would they locate their land or a particular parcel of land from a verbal (legal) description?
   c. How was the acreage on their farm estimated?
   d. How would they go about locating the best place for a main road or a new power line right-of-way to a specific location on the farm?

I. C. 2. If the majority of students in the class do not live on a farm, the material should be modified to reflect suburban or urban uses of maps and aerial photographs.

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

A. Have each student study a U.S. Geological Survey quadrangle sheet of the local area. Point out the map symbols, legend information, and the representations of elevation and relief.

B. Select a tract of land (at least 50 acres in size) in the local area that can be located on the topographic map from a legal description.

C. Have students study the terrain of the tract carefully on the map; measure the distance and direction of the boundary lines or selected roads within the tract; and determine the acreage of the tract, using the dot-grid method.

D. Take the students on a field trip to the selected tract. Have them use the topographic map to navigate to the property and study the map representations of elevation and relief, comparing them to their actual appearance. Photographs of objects and areas of the tract can be taken during the field trip and compared to the map symbols.

E. Locate the same tract on aerial photographs.

IV. EVALUATION

Interpretation of the map symbols, legend information, and the representations of elevation and relief on a U.S. Geological Survey map of the local area may take the form of written or oral test (90 percent accuracy required).

II. PRESENTATION

A. Understanding maps

A map is a graphic representation of the earth's surface or part of it, drawn to scale on a plane, with both human-constructed and natural features depicted by symbols, lines, and colors.

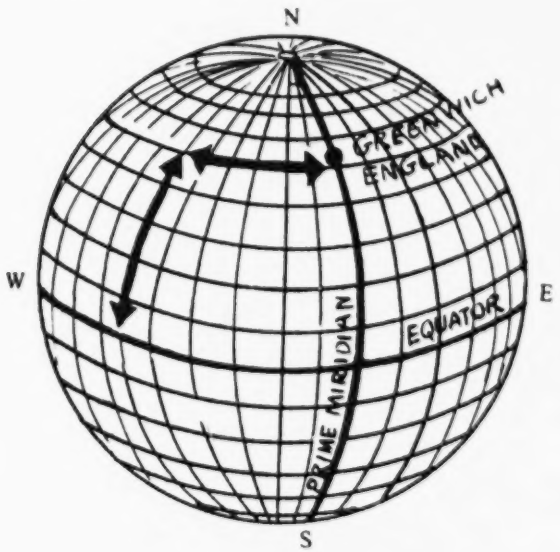
1. Types of maps

a. A planimetric map shows only the horizontal (flat) position of constructed and natural features (e.g., highway map).

b. A topographic map depicts both the horizontal and vertical (relief) positions of constructed and natural features. The distinguishing characteristic of a topographic map is the portrayal of the shape and elevation of the terrain with lines, colors, and symbols.

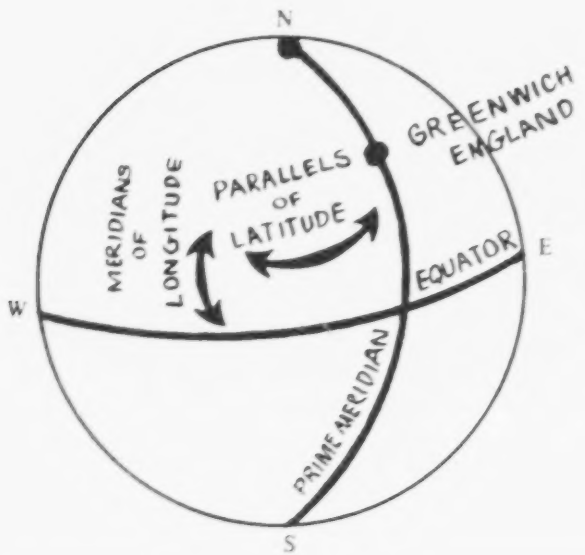
2. Map coordinates

Two-dimensional geographic coordinates are based on distances from an east-west line running through the equator and from a north-south line running through Greenwich, England. The line from the north pole to the south pole running through Greenwich is called the prime meridian.



Reference Lines for Geographic Coordinate Systems

II. A. 2. a. **Latitude**--the distance of a point north or south of the equator is known as its latitude, and the rings around the earth parallel to the equator are called parallels of latitude.



Position Location with Graphic Coordinates

b. **Longitude**--the distance of a point east or west of the prime meridan is known as its longitude, and the rings around the globe at right angles to the equator passing through the poles are known as meridians of longitude.

3. **Angular measure with geographic coordinates**

The unit of angular measure is the degree. Each circle is divided into 360 degrees, and each degree is 60 minutes. Starting at the equator, parallels of latitude are numbered from 0 to 90 north and 0 to 90 south. Direction north or south must always be given, since latitude can have the same numerical number on either side of the equator. The poles are at 90 north and south latitude.

Longitude lines are numbered 0 to 180 east and west of the prime meridian. The line directly opposite the prime meridian may have a value of 180 east and 180 west.

At any point on the earth, the ground distance covered by 1 degree of latitude is approximately 69 statute miles. The ground distance covered by 1 degree of longitude is approximately 69 miles at the equator, but decreases as one moves north or south to the poles until it becomes zero.

II. B. Map scales, directions, and symbols

1. Map scales

The scales printed on a map permit the determination of ground distance. To bring a map down to a useful size, everything on it is reduced in size at a uniform rate. The amount that objects have been reduced is indicated by the scale of the map.

a. Representative fraction (RF)

The scale of a map expresses the ratio of the horizontal distance on the map to the corresponding horizontal distance on the ground. The RF expresses this relationship as a fraction or ratio, for example, 1:24,000 or 1/24,000. The numerator, always written as 1, represents the map distance; the denominator, a larger number, represents ground distance. The RF is independent of any unit of measure and written as:

$$\text{Representative Fraction} = \frac{\text{map distance}}{\text{ground distance}}$$

The ground distance between two points on a map is determined by measuring the distance between them on the map and multiplying the map distance by the denominator of the RF.

b. Graphic scales

A graphic scale is a ruler printed on the map from which distances on the map may be measured. The straight line ground distance between two map points is determined by measuring the map distance with a ruler or a pair of dividers, then comparing this distance directly with the graphic scale.

2. Direction and azimuth

The direction of any line is the horizontal angle which is makes with the standard direction. The most important instrument for direction determination is the magnetic compass.

a. Magnetic vs. true direction

The point of the compass needle marked north points to the north magnetic pole rather than toward the north geographical pole (true north). This direction is called magnetic north. The angle formed between magnetic north and true north is called magnetic declination.

b. Azimuth

An aximuth is defined as a horizontal angle measured in a clockwise direction from a base line. Azimuths have values from 0 to 360 degrees.

c. Bearings

Bearings are horizontal angles referenced to one of the quadrants of the compass, i.e., NE, SW, SE, NW. Bearings are measured clockwise and counter-clockwise from north or south to east or west.

II. B. 3. **Color codes for map features**

Symbols depicting natural and constructed map features are usually printed in different colors to provide a more natural appearance and color. Each color represents a class of features. The color codes are as follows:

a. Black--the majority of cultural and human-constructed features
b. Blue--water features such as lakes, rivers, and swamps
c. Green--vegetation such as woods, vineyards, and orchards
d. Brown--the shape and elevation of the topography
e. Red--boundary lines, large highways, and special features
f. Occasional other colors--special information indicated in the legend

C. **Elevation and relief**

1. **Elevation**

The height of land surfaces in feet above sea level is called elevation.

2. **Relief**

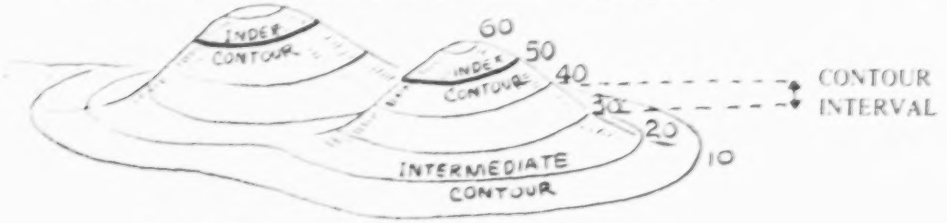
Relief is the variation in elevation of the earth's surface. Relief occurs in forms of hills, valleys, ridges, and the like.

3. **Representations of elevation and relief**

The method most commonly used for representing elevation and relief is that of contouring. Other methods used include the color-layer system. The color-layer system of color shading makes use of special arrangement of colors; each color representing a certain interval of elevation. The color scale for the elevations is shown in the map legend.

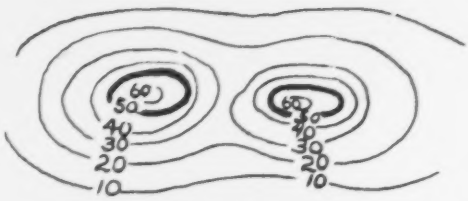
4. **Contour lines**

A contour line is an imaginary line of the ground connecting points of the same elevation. Contour lines indicate a vertical distance above or below sea level. The vertical distance between adjacent contour lines is known as the contour interval and the amount of the contour interval is given in the marginal information. On most maps the contour lines are printed in brown. Starting at the lowest elevation, every fifth contour line is heavier and darker than intermediate contours and is known as an index contour. Along each index contour the line is broken at some place and its elevation given. The contour lines falling between index contours are called intermediate contours. They are drawn with a thinner line than index contours and usually do not have the elevation given.



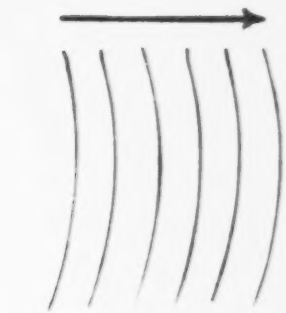
Saddle Between Two Hills (Side View)

II. C. 4. (Continued)



Contour lines of a saddle (top and map view)

The spacing of the contour lines shows the relief. Contour lines evenly spaced and wide apart indicate a uniform gentle slope. Contour lines evenly spaced and close together indicate a uniform steep slope. The closer the contour lines are together, the steeper the slope.



Uniform gentle slope

Uniform steep slope

D. **Uses of topographic maps**

Topographic maps are used for area measurement, road planning, agricultural planning, and recreation development.

E. **Fundamentals of aerial photographs**

Aerial photographs are photographs taken from aircraft. Through measurement of aerial photographs, it is possible to construct accurate maps containing a great deal of information about land forms, vegetation, and cultural features on the surface of the earth.

II. E. (Continued)

Most aerial photographs are vertical photographs and are taken with the camera axis held as nearly as possible in a vertical direction. These are used for preparing planimetric and topographic maps, for land-use surveys, and for forest management and logging surveys.

1. **Information appearing on aerial photographs**

   a. Agency responsible for the photograph is listed on the back.
   b. An alphabetic code for the county, a flight line number, and the photograph number appear in the upper righthand corner.
   c. Date of photography appears in the upper lefthand corner.
   d. Time of photography may appear to the right of the date on the first and last photograph of a continuous strip.
   e. Fiducial marks (half-arrows or small crosses) appear either in the four corners or midway along the border of the print. (The intersection of lines connecting opposite fiducial marks locates the optical center of the photograph, known as the principal point.)
   f. Scale of the photograph may appear on the face or stamped on the back of the photograph.

2. **Photograph scale**

   a. **Photo scale**

   The vertical photograph represents a true record of angles, but horizontal distances are subject to wide variations because of changes in ground elevation and flight altitude. The scale is generally stated in terms of the representative fraction (RF) just as on maps, and is independent of the units of measure.

$$RF = \frac{\text{photo distance between two points}}{\text{ground distance between same two points}}$$

   b. **Area determination**

   The area on a photograph (or map) is determined as the square of the denominator of the RF. For example, given an RF of 1:15,840 means that 1 inch equals 15,840 inches, or 1 inch equals 1320 feet, or 1 inch equals 20 chains (66 feet per chain). Therefore, 1 square inch on the photograph equals 400 square chains, or 40 acres.

   c. **Compass bearings**

   Few flight lines are oriented in exact cardinal directions (N, S, E, or W); therefore, a reference line of known direction must be established before bearings to various objects can be determined.

   An aerial photograph is NOT a map! The single aerial photograph is not a map because of image displacements due to topography and photographic tilt. The photo scale is only constant on the datum plane. An accurate map cannot be constructed or traced directly from photographs unless the ground being mapped is perfectly level and the photographs were taken with no appreciable tilt.

II. F. Uses of aerial photographs

The advantages of aerial photography lie in the accuracy and speed for obtaining information of the physical features of relatively large, often inaccessible areas. Aerial photography can be more economical than other methods of survey.

1. Area measurement

There are several methods of estimating size of irregular areas. Two of the more common methods include planimeters and grids.

a. Planimeters

The planimeter is a mechanical device consisting of several small wheels, a numerical dial, and a tracing arm. The boundary of the area is traced with the point on the tracing arm in a clockwise direction, and area in square units can be read on the instrument dial. Planimeters yield accurate measurements if carefully used.

b. Grids

Grids consist of intersecting lines forming rectangles or squares, which are drafted onto the map or photograph or simply superimposed by means of a transparent overlay. Each grid or square is assigned an area value according to the scale of the photograph. For instance, if a grid contains 1,000 squares and 450 of them fall in a particular area, the size is thus 450 times the acreage or the area of an individual square. A modification of the grid called the dot grid consists of systematically placed dots on a transparent plastic overlay. The dot grid is placed over the photograph or map and the number of dots falling within the effective area counted. The acreage per dot is multiplied by the number of dots to obtain the total acreage. These overlays are available from suppliers of forestry materials.

Unit 6— Managing the Forest (Silviculture)

TASK ANALYSIS:

Performance Objective

Given management guidelines, plan a timber stand improvement (TSI) project of planting, thinning, and pruning a stand of uneven-aged or even-aged forest. The plan must be rated acceptable according to the guidelines provided.

Enabling Objectives

1. Identify the factors which comprise a stand analysis.
2. State reasons for intermediate cuttings.
3. Explain the process, application, and advantage of selection cutting in uneven-aged stands.
4. Identify the disadvantages of cutting of even-aged stands to a diameter limit.
5. Explain how reproduction can be secured when clear cutting even-aged stands.
6. State the requirements and advantages of the Virginia Seed Tree Act.
7. Identify the steps in the process of shelterwood cutting.

Criterion-Referenced Measure

Plan a TSI project to plant, thin, and prune a stand of even- or uneven-aged forest, to be rated acceptable according to guidelines provided by the instructor.

Selected Instructional Activities

1. Discuss stand analysis factors, reviewing procedures for determining forest type and ages of trees.
2. Analyze and discuss the local forest situation--the percentage of privately owned versus government/industry owned forest land, common forest types, even-/uneven-aged stands, the most profitable trees and tree products, harvesting practices, and disposition of low-value trees.
3. Discuss types and advantages of intermediate cutting.
4. Explain the methods of harvesting uneven- and even-aged stands. Emphasize the disadvantages of cutting even-aged stands to a diameter limit.
5. Discuss the provisions of the Virginia Seed Tree Act.
6. Discuss various types of clear cutting of even-aged stands and how reproduction is secured with each type of cut.
7. Explain circumstances under which shelterwood cutting is advantageous, and why it is not used to a great extent in Virginia.
8. Conduct field trips to illustrate stand analyses, intermediate cutting, and harvest cutting.

Selected Tools and Materials

Increment borer, diameter tape, or Biltmore stick
Abney level
Projector (filmstrip) and screen

Selected Audiovisual Materials

Filmstrip: Managing the Forest. Filmstrip No. 6, Virginia Forest Series (#01750). Audiovisual Services, Virginia Department of Education.

Selected References

Even Aged Silviculture for Upland Central Hardwoods. USDA Forest Service Agriculture Handbook 335.
Growing Loblolly Pine. USDA Farmer's Bulletin 2097.
Managing the Small Forest. USDA Farmer's Bulletin 1889.
Management and Inventory of Southern Hardwoods. USDA Agriculture Handbook 181.
Patterns for Preservation--A Conservation Text. David Tillotson.
Timber Stand Improvement in the Southern Appalachian Region. USDA Miscellaneous Publication 693.
Virginia's Timber. USDA Forest Service Resource Bulletin SE-44.

LESSON PLAN:

I. PREPARATION

Motivation

1. Lesson approach

a. Once established, the forest will probably grow by itself. However, application of established management practices can improve the quantity and quality of wood products in a given forest area, thereby increasing the income from the woodland.

b. These management practices have evolved from an understanding of how trees grow, which tree species produce the most valuable products, and under what conditions certain trees grow best.

c. Since tree species vary in their requirements as to soil, moisture, climate, ability to endure shade, etc., the most suitable management practices must be determined for each local area.

d. In the study of forest management, it should be remembered that the economics of our society sometimes force acceptance of certain prevailing practices which are compromises between the best scientific knowlege and economic opportunities.

e. In addition to the production of timber products, the forest has other uses, such as watershed protection, wildlife habitat, and recreation, which actually may be the best use for a forest in a particular location or circumstance.

2. General situation

a. Forest industry and government own 23 percent of Virginia's forest land. This land is, for the most part, reasonably well managed.

b. The remaining 77 percent of the forest land owned by private landowners is, to a large extent, poorly managed.

c. To meet the future needs for forest products, the private landowners must increase their forest production through good management.

3. Local situation

The following questions should be answered during class discussion and illustrated through field observations:

a. What percentage of the local forest land is owned by forest industry and government?

b. What percentage of the local forest land is privately owned?

c. What common trees grow in the local area?

d. Are the local timber stands generally even-aged or uneven-aged?

e. Which trees sell best, are the most profitable, have good markets for their products, or grow best in the local forest?

f. What general harvesting practices are the most widely used in the local area, and do these practices contribute to best production in the long run?

g. What happens to the undesirable, unmerchantable trees: are they left to grow and occupy valuable space, and will the managers of the forest restock with similar low-value trees?

h. Is erosion a hazard as a result of cutting operations in the local area, and if so, are watershed values usually protected by proper planning of skid roads?

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

Instruction in forest management depends to a large extent on field trips to illustrate cutting, thinning, and planting methods and to give students practical experience in planning improvement of timber stands. The following field trips are suggested:

A. Assign each student a plot on which to perform and record a stand analysis:

CIRCULAR PLOT DIMENSIONS

Plot Area	Radius in feet
1/2 acre	83.26
1/4 acre	58.88
1/5 acre	52.66
1/10 acre	37.24

B. Visit several age classes of immature timber to illustrate various types of intermediate cutting.

C. Visit several mature stands of timber and have students recommend harvesting methods.

D. Contact a forest industry representative or local forester for assistance in locating areas in which cutting is taking place. Visit sites to illustrate the various types of cutting. Have students observe results obtained on areas previously cut.

E. Visit logging areas and have students examine for active erosion. Point out how proper planning and layout of skid roads can prevent erosion.

F. Number 50 trees in an immature pine stand. Have students decide whether to take or leave each numbered tree, and give reasons for the decisions.

IV. EVALUATION

In addition to completing the project outlined in the Criterion-Referenced Measure, students may take a written test on definitions and objectives of various cutting methods.

FOREST MANAGEMENT

II. PRESENTATION

A. Stand analysis

Our first consideration must be to determine what conditions exist in the woodland to be managed. To do this, we must take a close, careful look and note the important facts:

1. Composition of the stand

What species of trees are present?

2. Forest types

In what proportion are these different species present? (See Unit 4 for definitions of forest types.)

3. Age

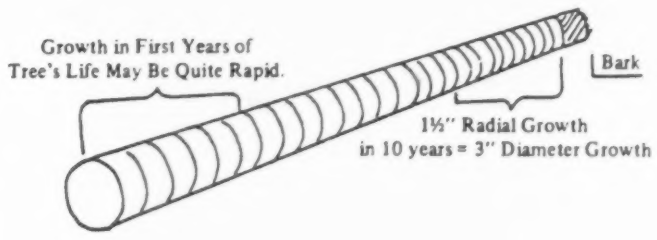
What is the age of the important species? By using an increment borer or by counting growth rings on a recently cut stump, we can determine whether the stand is immature or mature.

4. Age distribution

Using above age count, we can determine if the stand is even- or uneven-aged. A stand is usually considered even-aged if there is less than 10 years difference between individual trees. This will be a guide to later recommendations of management practices.

5. Growth rate

Still using the same increment core or stump, we can determine the growth rate. One accepted means of expressing growth rate is by measuring the radial growth in the last 10 years and doubling it to determine the diameter growth of the tree during this period. In assessing this figure, we must remember that young trees normally grow rapidly. However, as the diameter of the tree increases, a much narrower ring may represent a proportionately larger volume growth. As a rough guide, we may assume that for trees up to 30 years of age, good growth would equal approximately 3 inches diameter growth in 10 years. On older trees, a smaller increase of about 2 inches would be classed as satisfactory.



6. Size

Using a Biltmore stick or diameter tape, we measure the DBH (diameter breast high--4-1/2 feet from ground) of the trees on the plot. The Biltmore stock can also be used to measure the merchantable height of the trees in 16-foot logs or number of 5-foot sticks of pulpwood. (See Unit 8 for definition of products.)

II. A. 7. **Trees per acre**

This figure is especially important in young pine stands to assist in determining the need for thinning.

8. **Quality of site**

From the condition of the trees and our knowledge of tree requirements, we determine if the site would be good for growing this species.

9. **Products available**

Decide the products available now or those which the stand should be managed to produce.

10. **Reproduction**

Is reproduction present and, if so, of which tree species is this reproduction necessary or desirable? Remember that in even-aged management, we seldom want reproduction until the time of final harvest. However, in managing hardwood stands under the selection system to be discussed, we need trees of all ages in our stand, and reproduction of good species is valuable.

After obtaining all necessary information,we are now in a position to make a decision as to the best management practices to apply to our timber. Our next step is to understand these practices thoroughly.

B. **Intermediate cuttings**

These are cuttings made in an immature stand. Each type of intermediate cutting to be discussed is designed to meet specific forest needs. However, in actual practice, most cuttings result in accomplishing several objectives, and therefore are combinations of the different types.

1. **Thinning**

Thinning an immature stand to maintain or improve growth rate is usually applied in even-aged stands.

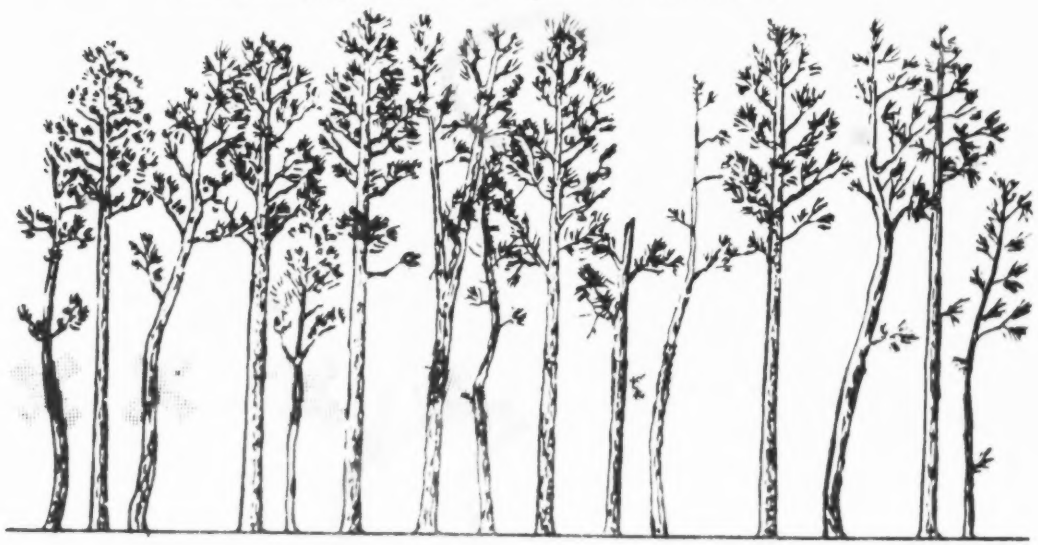
a. During early years in both natural and planted stands, there are always many more trees present than can grow to maturity, due to competition for growing space, nutrients, and moisture.
b. If possible, thinning should be done early enough in the life of a stand to prevent usual loss of growth which occurs as a result of intense competition.
c. Young, even-aged stands may need thinning when 15 years old, or possibly at an earlier age on good growing sites.
d. Due to its cost, thinning is usually delayed until the trees to be cut will produce merchantable products such as pulpwood or posts.
e. A thinning should be planned when the following conditions exist:
   (1) Tops or crowns are interlaced or touching.
   (2) The length of the live crown is less than 30 to 40 percent of the total height of the trees.
   (3) There are many dead or dying trees present in the stand.

II. B. 1. f. Trees that are excessively limby, crooked, diseased, or injured should be removed.

g. In clusters or groups of good trees, sometimes the removal of two or three trees from the center will result in freeing the remaining crowns, although spacing may not be ideal.

h. Periodic incomes as a result of properly planned thinnings in a timber stand make timber production more attractive economically.

i. Regular thinnings in a stand tend to put growth on selected trees. This means trees of highest quality will be produced and consequently, greater returns per acre will result.



Removing crooked, limby, diseased, forked and suppressed trees provides growing space for quality trees.

2. Other improvement cutting

Cuttings other than for final harvest are made during the life of a stand for purpose of improving its composition or condition.

a. Release cutting

This practice frees trees from harmful competition by felling, girdling, or poisoning inferior trees, and is usually applied to young stands. For example, release cutting is used in pine stands to remove or kill overtopping or competing inferior hardwoods, permitting free growth of young pines. It is used in hardwood stands to free good, valuable hardwood trees from injurious effects of overtopping or competing low-value hardwoods.

b. Salvage cutting

These cuttings are made to remove dead, badly injured, or suppressed trees in order to use merchantable material before it becomes worthless. For example, salvage cutting may be applied to pines damaged by red heart rot or to hardwoods with bad fire scars.

II. B. 2 c. **Sanitation cutting**

These cuttings are made to remove trees killed or injured by fire, disease, or insects to prevent the spread of the disease or insect attack. For example, trees are cut to prevent the spread of oak wilt or Dutch elm disease, or to prevent new broods of pine beetles from spreading damage after pines have been attacked.

C. **Harvest cutting**

These are cuttings made for the removal of mature trees.

1. **Uneven-aged stands**

Selection cutting consists of the removal of mature timber, usually the oldest or largest trees, either singly or in small groups at relatively short intervals, repeated indefinitely. The openings made during each cutting must be large enough to permit reproduction of acceptable tree species if an uneven-aged forest is to be maintained.

a. This method has been used chiefly in hardwood stands, since it was believed that hardwood tree species were able to grow satisfactorily in the partial shade of the relatively small openings created by this system of cutting. Recent research findings have revealed that stands resulting from a series of cuts have not met expectations from the standpoint of composition or quality. Present economic and market conditions should be carefully considered before deciding to apply this type of cutting. The method is definitely not suitable for intolerant trees. (Refer to tolerance table in Unit 4).

b. To apply this method, the forest manager looks over each tree to decide whether it should be cut or left to grow. Usually, some improvement cutting is done at the same time to remove defective or diseased trees. Trees to be cut are those past their best growing period or which will bring greatest return if cut now.

c. Primary advantage of this method is that it allows a cash return every few years, and this is often desirable for small ownerships. This advantage is often limited by lack of markets to handle small amounts of material.

2. **Even-aged stands**

Caution: The practice of cutting even-aged stands to a diameter limit, which really amounts to cutting the largest and best trees, is most unsound. It leads to complete degeneration of the stand, since the trees left are not the younger trees, but the trees that have been losing out in the struggle. In timber that has reached sawtimber age and size, most of these smaller trees have gone beyond the point where they can recover and put on satisfactory growth. This mistake is repeatedly made by uninformed owners.

II. C. 2. a. **Clear cutting**

This method consists of removing the entire stand in one cut. Using this method, reproduction is secured in one of two ways:

(1) Planting of tree seedlings or direct seeding of the area following cutting assures new growth.

(2) Natural reproduction is obtained by seeding from trees cut in the clearing operation. This is chiefly of value in pine stands and to be reasonably sure of success, the stand should be cut in a good seed year, during or immediately following seed fall. In hardwood stands reproduction is often secured as a result of stump sprouting and from underground rootstocks.

b. **Clear cutting in strips or blocks**

In this method the stand is divided into a series of strips or blocks; one area is cut and the next is left uncut.

(1) Reproduction is secured by seed from the adjoining uncut areas. After reproduction is secured, the uncut areas are then harvested and reproduction is secured as in routine clear cutting. There are many variations of this system, and competent advice should be obtained so that the plan may be tailored to the particular conditions.

(2) One advantage of this method is that it permits the income from timber to be spread over a period of years. However, it would be of doubtful value for species other than pine.

NOTE: Written permission must be secured from the Virginia Division of Forestry to clear cut in stands containing pine or yellow poplar. The seed tree law provides that pine timber may be clear cut if such practice is part of a reforestation plan approved by the state forester prior to cutting.

c. **Seed tree cutting**

This practice removes the timber stand in one cut, except for selected seed trees properly spaced to reseed the area.

(1) The Virginia Seed Tree Law requires that in any cutting of pine (loblolly, shortleaf, pond, or white pine) timber, at least eight cone-bearing pines with a minimum stump diameter of 14 inches must be left uncut on each acre. In any cutting of yellow poplar, the law requires that two trees having a stump diameter of 14 inches must be left uncut on each acre. Complete details of this law should be understood before cutting is begun.

(2) Trees, like farm animals, should come from the best parents; therefore, seed trees should be selected with care and should be among the best trees of the stand.

(3) Seed trees should be removed after reproduction is well established and before young trees become too large. According to Virginia law, seed trees must remain standing for three years.

II. C. 2. c. (4) The advantage of this method is that timber can be harvested and reproduction secured without additional effort or expenditure by the owner, providing all conditions are favorable. It should be thoroughly understood that simply leaving eight seed trees will not in itself ensure reproduction. The soil must be well disturbed, hardwood brush must be eliminated, and cutting must be done in a good seed year during the fall and winter months. Unless these conditions are met, a satisfactory young stand is unlikely. As a result, many timberland owners secure prior approval of a reforestation plan which allows the seed trees to be cut, and the stumpage value they represent may then be used to replant the area with desired tree species.

d. **Shelterwood cutting**

This method removes the timber stand by a series of partial cuts which extend over a period of years.

(1) Usually this is accomplished in three separate cuts. The first cut removes undesirable trees, prepares a seed bed, and releases selected seed trees. The second cut removes enough of the stand to permit reproduction to become established. The third cut, which takes place about ten years after the first, removes the remainder of the stand.

(2) The advantage of this method is that there is a plentiful seed source from which to secure reproduction, and the income from the timber is received over a period of years.

(3) This method has been used with good results under certain specific conditions. In Virginia it should be used only after careful consideration, for the light requirements (tolerance) of major pine species and also of many better hardwood species are such that the method produces unsatisfactory growth.

Unit 7— Reproducing the Forest

TASK ANALYSIS:

Performance Objective

Given guidelines on forest management and a site (or a description of a site) in need of tree regeneration, list and describe five regeneration techniques with 100 percent accuracy and select one or more of these techniques for application to the selected site according to the management guidelines provided.

Enabling Objectives

1. List and describe the methods of site preparation for tree reproduction.
2. List and describe natural methods of tree reproduction.
3. Identify the advantages and disadvantages of natural methods of tree reproduction.
4. Explain factors that affect the quality of the seed source.
5. List and describe the artificial methods of tree reproduction.
6. Explain the purpose of the Virginia Seed Act.

Criterion-Referenced Measure

List and describe five tree regeneration techniques with 100 percent accuracy and apply one or more of these techniques on a selected site, according to the management guidelines provided.

Selected Instructional Activities

1. Conduct field trips to several forest sites in need of regeneration. Discuss with students how the sites might be prepared for reproduction and the various methods of regeneration which could be applied.
2. Invite a professional forester to discuss regeneration techniques with the class.
3. Arrange a field trip to selected nurseries or seed orchards.

Selected Tools and Materials

Instructor-provided forest management guidelines
Instructor-prepared test on tree regeneration techniques
Seedlings and seed
Hand seeding machine (cyclone seeder)
Projector

Selected Audiovisual Materials

Filmstrip:	Reproducing the Forest. Filmstrip No. 7, Virginia Forest Series (#01750). Audiovisual Services, Virginia Department of Education.
Filmstrip:	Equipment for Reforestation and Timber Stand Improvement, pp. 3-160. USDA, Forest Service.
Filmstrip:	National Forest Landscape Management: Timber. USDA, Forest Service.
Filmstrip:	Principles of Silviculture. pp. 371-415. Theodore Daniel, John Helms, and Frederick Baker.
Filmstrip:	Revegetation Equipment Catalog. USDA, Forest Service.
Filmstrip:	Seed and Planting Stock Dealers. USDA, Forest Service.

LESSON PLAN:

I. PREPARATION

Motivation

1. **Lesson approach**

   a. One of the keys to continuing success in forest management is the ability to reproduce desirable forest stands when needed.
   b. Many ingenious schemes are found in nature to accomplish reproduction of the various tree species; however, often the low-value species will reproduce most efficiently and successfully.
   c. It is sometimes necessary to apply certain tecniques to assist or guide natural reproduction.
   d. Often it is impossible to secure desirable tree reproduction naturally; in this case, direct seeding or planting is used to begin a new stand.

2. **General situation**

   a. There are over one-half million acres of idle agricultural land in Virginia.
   b. There are approximately one-half million acres within the commercial forest areas that are nonstocked and can be planted without site preparation.
   c. There are several million acres of forest land that are poorly stocked and need to be planted following site preparation.

3. **Local situation**

   The instructor should determine local practices relative to renewing the forest, establishing forest on land previously used for another purpose, and removing undesirable trees and brush from the forest area.

II. PRESENTATION

The presentation, which can be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

A. Arrange field trips to several sites where students can observe site preparation methods.
B. Have students examine an area which has been reforested, and interview the owner to determine how the reforesting was done and results expected.
C. Have students visit a nursery or seed orchard.
D. Have students participate in planting of seeds or seedlings at selected sites.

IV. EVALUATION

A. Written or oral test on explanation of tree regeneration methods (100 percent accuracy).
B. Participation in planting project.

II. PRESENTATION

A. Site preparation

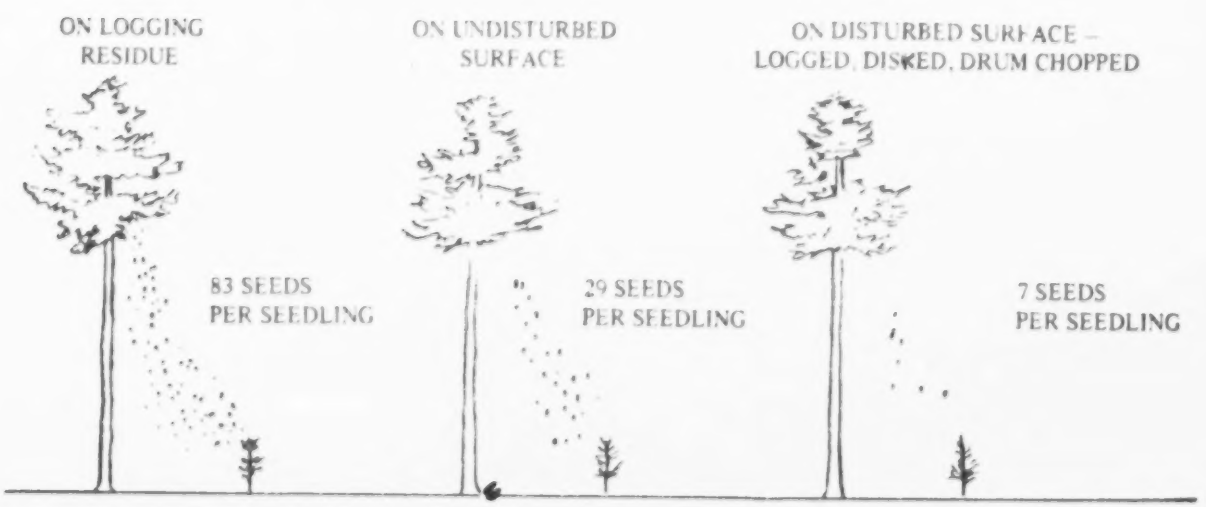
Regeneration or reproduction of forest trees is accomplished naturally in many ingenious ways. Edible fruits and nuts are distributed by animals and birds. Papery wings and silken parachute attachments carry seeds in the wind, while hook devices fasten to fur or clothes for transport. Most of these methods are effective, providing the spot where the seed finally lands is favorable for the germination and growth of the particular tree species involved.

As we learned in Unit 4, these specific site requirements are often quite complex, but since they undoubtedly determine the success or failure of this vital phase of our efforts to manage the forest, we must understand at least the basic requirements of the more valuable tree species. This knowledge can then be used to make certain that conditions in our stand are suitable for the reproduction on the tree species we desire to establish.

1. Methods

Most hardwood forests reproduce quite abundantly and with a wide variety of species if protected from grazing and fire. Numerous hardwood species are able to reproduce by sprouting from stumps and underground rootstocks, as well as from seed. Therefore, site preparation measures usually are limited to making certain that the openings in the forest stand are large enough to ensure sufficient light for growth of high-value species. For example, yellow poplar must have full sunlight and exposed mineral soil to germinate and develop.

Since pure pine stands are not naturally a part of the permanent forest types in Virginia, and since they reproduce successfully only under favorable conditions, it is often necessary to use certain methods of site preparation, described as follows, to create these conditions. Occasionally, these same methods are suitable for use with some high-value hardwood stands.


ON LOGGING RESIDUE
ON UNDISTURBED SURFACE
ON DISTURBED SURFACE – LOGGED, DISKED, DRUM CHOPPED
83 SEEDS PER SEEDLING
29 SEEDS PER SEEDLING
7 SEEDS PER SEEDLING

Number of Seeds Needed to Establish One Pine Seedling on Different Classes of Seedbed

II. A. 1. a. **Drum chopping**

In this operation an implement known as a rolling drum chopper is pulled through the cutover area by a large crawler tractor. The chopper consists of a heavy metal cylinder with large knives attached at intervals. The tractor and cylinder mash and flatten unwanted weed trees to the ground, while the knives serve to cut and tear the tree stems and to expose mineral soil. Under certain conditions this operation may be sufficient to create a satisfactory site for planting or seeding without additional treatment. Usually, however, it is necessary to follow drum chopping with prescribed burning after an interval, to allow the leaves and woody fuel to dry. This equipment has, to a large extent, replaced the use of a disk on recently logged areas and also on areas occupied by sprouts and small trees of unwanted tree species.

b. **Disking**

This involves pulling a large, heavy, disk-type harrow through the woodland either before or after cutting. This usually accomplishes two purposes: first, the destruction of the unwanted hardwood undergrowth, and second, the disturbance of the forest floor to expose mineral soil and encourage germination of desired seed. If done prior to cutting, disking creates a favorable seedbed for all the seed from the stand and normally gives assurance of abundant reproduction. If the disking follows cutting operations, it is considerably less efficient due to stumps, tops, and lesser amount of seed; nevertheless, if an ample seed source is available, reproduction is usually secured. The most advantageous time to disk is from midsummer to the time of seed fall, but it has been found effective when applied at almost any season.

c. **Bulldozing**

In this method a medium to heavy crawler-type tractor is used with a straight or toothed type blade to scrape off the upper layer of the forest floor. This eliminates the undersirable hardwood undergrowth and also exposes mineral soil. Usually bulldozing is done after logging to reclaim or convert areas to pine that have been invaded by unwanted hardwoods. Material pushed up is either dumped in scattered piles or in windrows and left to decompose naturally.

Some advantages of this method over disking are immediately apparent. It more completely eliminates the hardwood brush and exposes a larger percentage of mineral soil, thus creating a longer lasting seedbed. However, it has some serious disadvantages in that a certain amount of top soil is unavoidably removed, and the soil conditions therefore become less favorable. The method is unsuited to areas subject to any considerable erosion, and in addition, it is more time-consuming and consequently more costly than disking. It is definitely unsuited to heavy-type soils which are compacted by heavy equipment.

II. A. 1. d. **Prescribed burning**

The use of carefully controlled fire to prepare a site for planting or direct seeding has become an accepted practice in Virginia. Used either by itself or in connection with drum chopping or chemical spraying, fire has proven to be an effective and economically practical method for eliminating logging debris and reducing weed tree species competition. There are certain factors involved with the use of fire which must be understood before finally deciding on its use. Fuel conditions and weather factors can determine the success or failure of any burning effort. Plans for control and assessment of the risks involved should be thoroughly considered. Seeking professional recommendations and guidance is strongly urged. Fire can be effective and comparatively economical if wisely used, or completely ineffectual and extremely costly if used without planning.

e. **Use of tree poisons (silvicides)**

The primary use of chemicals is to kill the unwanted vegetation so that desirable trees have room to grow.

There are several good silvicides on the market and more are being developed and tested. Because of new developments in the chemical field, it is not practical to list the currently accepted silvicides. Up-to-date information should be obtained from local professionals.

Silvicides must be used according to the directions on the label. Improper use can cause damage to the environment and the person using the chemical.

f. **Girdling**

This is effective on most trees 12 inches in diameter and larger. Girdling is accomplished by cutting a band 3 to 6 inches wide entirely around the tree, making certain that the axe cuts sever the cambium and penetrate well into the wood.

II. B. Seed source

It is an accepted fact in agricultural research that the quality of a seed directly determines the quality of the plant it will produce. Like the breeding of farm animals, the quality of an offspring depends upon the characteristics of both parents that produce it. These characteristics are inherited qualities which may result in good or bad tendencies. Trees and their offspring are governed by the same laws of inheritance as corn, tobacco, or hogs.

It follows then, that not only is an ample seed source important, but also more attention must be paid to the quality of tree seed if we are to improve our woodland. Certain information must be understood about tree seed if we expect to manage the forest properly.

1. Genetic considerations

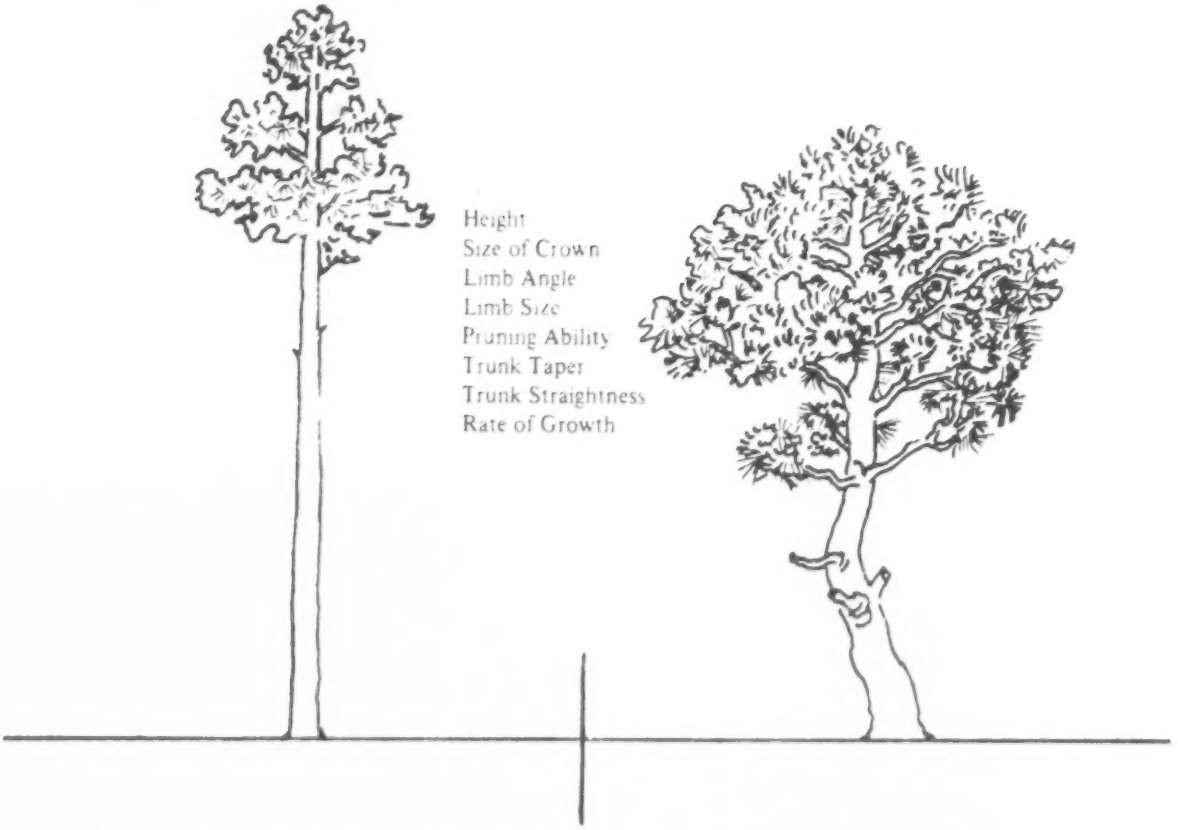
Many characteristics of trees formerly believed to be the result of environment are now known to be the result of inheritance. A list of these would include height growth, limbiness, size of limbs, and angle of branching. Certainly these qualities can be influenced by environment, but they are determined largely by the tendencies passed down from parents. Virginia is among the leading states in the nation in putting this knowledge to practical use. Superior pine trees of four species (white, loblolly, shortleaf, and Virginia) have been used as parent stock to establish seed orchards. These "superior" trees have been selected for extremely desirable characteristics after a search of thousands of forest acres within the state. After these selected trees are culled down to a limited number of the very best specimens, small pieces of branches are removed and grafted to healthy rootstock. The resulting tree will produce seed at an early age, with inherent "superior" characteristics. These trees are systematically planted in a seed orchard from which superior seed is harvested. From such select seed are grown tree seedlings that have the superior genetic characteristics of their parents. These seedlings are sold to Virginia landowners for reforestation purposes. In this way, seed to restock our woodland comes from our best trees, not from the spindly, poorly formed "runt trees." We should spare no effort to select the best trees as seed trees to regenerate our forests.

2. Location of seed source

The geographic location of the source of tree seed we use is also important. Certainly if we rely on our own seed trees, then this consideration is of no concern, but purchase of tree seed collected from distant areas of the country or from drastically different climate areas is unwise. It has been shown by research and testing that both survival and growth are materially decreased if tree seeds originate from distant sections of dissimilar environment.

II. B. 2. (Continued)

INHERITED CHARACTERISTICS



3. **Frequency of good seed years**

Most tree species vary markedly from year to year in size of the seed crop produced. This knowledge and the ability to predict a good seed crop enables the forest manager to harvest timber during good seed years; or if economics force cutting in a poor seed year, the manager is aware that other means may be necessary if reproduction is to be secured.

Closely associated with amount of seed produced are changes in quality of seed. The poorer the crop, the smaller the percentage of viable seeds that will germinate and grow. Thus it is vital to know the seeding characteristics of the important trees. How often do good seed years occur? Are some seed produced each year? What time of year do the seeds mature? What percent of germination can we normally expect? The forest manager must know these answers to generate the forest successfully.

II. B. 4. **Virginia Seed Tree Act**

In an attempt to ensure a uniform source of seed to perpetuate reproduction of some of the more valuable timber-producing species, a seed law was passed by the General Assembly. Briefly, this law provides that any person cutting timberland on which loblolly, shortleaf, pond, or white pines compose over 10 percent of the stand, must leave uncut at least eight pines per acre measuring 14 inches or more in diameter. Two yellow poplar trees 14 inches or more in diameter must be left standing on timberland where this species occurs. These provisions are only minimum measures, and often twice this number of trees, plus some site preparation measures, are needed to ensure adequate reproduction.

Since the basic objective of the Seed Tree Act is to procure prompt reforestation of cutover land, Section 10-83 of the Code of Virginia permits a person not to leave seed trees, provided he or she secures the approval of the state forester for an effective reforestation plan to be carried out following cutting of the timber.

C. **Natural methods of reproduction**

In this category are listed the various processes by which a forest is renewed as a result of self-sown seeds. Here we use the seeds from trees already part of our forest to reproduce a similar forest.

For successful natural reproduction, three conditions must be achieved: (1) abundant seed supply; (2) favorable conditions for germination of seed; and (3) favorable conditions for the growth of young seedlings.

1. **Method descriptions**

Generally, in any reproduction method two activities are involved: first, the removal or harvest of the timber stand, and second, its replacement with a new stand of young trees. There have been many of these methods developed, but most are variations of similar principles. In Virginia we need only consider three such methods. (These have been described at some length in Unit 6 under cutting methods.) Under any of the three methods, seed trees are selected in advance of cutting operations and marked with paint, rags, cards, or other identification.

a. **Selection method**

Since only selected trees are cut at any time, reproduction comes from seed produced by remaining trees in the stand or from stump sprouts. As previously noted in Unit 6, reproduction and growth of young trees have proven satisfactory in most instances when this method is used.

b. **Clear cutting**

Reproduction may come as a result of seed from all trees harvested if cutting is done during or immediately after seed fall. However, if this method fails to produce a satisfactory stand, then some form of artificial reproduction must be substituted.

II. C. 1. c. **Seed tree cutting**

Under this system, reproduction depends on seed produced by trees reserved for this purpose during harvest cutting. The number of trees to leave varies with tree species, seed productivity, age of stand, and other factors, but usually ranges from 8 to 12 trees per acre. Since immature trees usually bear only small quantities of poor quality seed, it is important that seed trees selected be proven seed producers. Also, it is important that consideration be given to the genetic qualities of the trees selected. Care should be taken that seed trees are spaced uniformly over cutting area to ensure uniform coverage.

SPACING GUIDE

Trees Per Acre	Feet Between Trees
2	148
4	104
6	85
8	74
10	66
12	60
14	56
16	52

2. **Advantages of natural methods of reproduction**

a. It is generally regarded as the least expensive system.
b. The species is adapted to local climatic conditions.
c. It is suited to low, wet areas where use of heavy equipment is impractical.

3. **Disadvantages of natural methods of reproduction**

a. Valuable time is perhaps lost securing new stand.
b. Control of species reproduced is often difficult.
c. Uniform stand is difficult to achieve.
d. Reproduction results are variable, depending on size of seed crop, bird and rodent population, etc.
e. Reproduction is often too dense, with intense competition slowing growth.

D. **Artificial methods of reproduction**

Methods covered in this grouping are planting and direct seeding. Since these methods involve physical planting of either tree seedlings or tree seed, they also involve selecting the species to be used. It cannot be too strongly emphasized that this selection must be carefully made to ensure that the species is suitable for the environment in question and for the markets available. Securing the advice of a local forester or other person competent to weigh the facts of the situation is strongly advised.

1. **Planting**

This has been the commonly accepted method for artificially renewing the forest. Thousands of acres of plantations in Virginia and most other states testify to the general success of the work.

II. D. 1. a. **Selection of planting stock**

Loblolly and white pines have been the most successful species in Virginia. Loblolly, shortleaf, and Virginia pines are raised in one year at nurseries, while white pine is kept in the nursery for two years. Hardwoods are more demanding in the amount of planting care required and have generally been less successful in plantations.

b. **Survival rate**

With favorable weather conditions and good planting procedures, survival rate should be at least 70 percent.

c. **Season to plant**

Best results are obtained during the dormant season when growth of seedlings is slowest. Depending on the weather, the best time to plant is from February 1 to April 15.

d. **Tools used**

(1) Various types of tractor-drawn tree-planting machines are available. These units are capable of planting approximately 1,000 seedlings per hour. Tree-planting machines may be rented from the Virginia Division of Forestry.

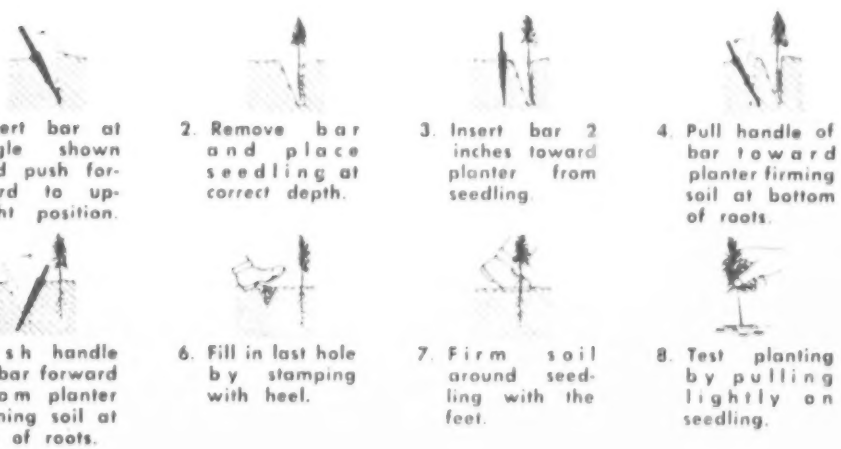
(2) Hand shovels, mattocks, grubbing hoes, and planting bars can all be used for planting. The planting bar has the widest acceptance, especially in the Piedmont and Tidewater sections of Virginia; it is often rather inexpensive and can be made in the school or farm workshop. (See Appendix for scale drawing of planting bar.)

e. **Care of planting stock**

Bundles should be stored off the ground in a shady, cool (not freezing) location, with space around the bundles for ample air circulation.

f. **Planting procedure**

The seedlings purchased from the Division of Forestry have been treated with kaolin clay. This material seals in the moisture and should not be washed off. During planting, the seedlings should be carried in a planting bag or container, and the roots must not be exposed to the sun or drying winds.



1. Insert bar at angle shown and push forward to upright position.
2. Remove bar and place seedling at correct depth.
3. Insert bar 2 inches toward planter from seedling.
4. Pull handle of bar toward planter firming soil at bottom of roots.
5. Push handle of bar forward from planter firming soil at top of roots.
6. Fill in last hole by stamping with heel.
7. Firm soil around seedling with the feet.
8. Test planting by pulling lightly on seedling.

II. D. 1. g. **Spacing of trees**

Usually from 700 to 800 trees are planted on each acre, which means that spacing may vary from 8 by 8 feet to 7 by 8 feet. In cutover timberland, spacing will vary due to stumps, tree tops, etc., but at least 600 to 700 trees should be planted wherever possible.

h. **Securing trees**

Forest tree seedlings are available from nurseries operated by the Virginia Division of Forestry. Information concerning purchase of trees can be obtained from chief forest wardens, county forester, or nearest district office.

i. **Pales weevil damage prevention**

Because of the likelihood of pales weevil damage, it is advisable to delay planting pine seedlings for one year in a cutover pine woods, or to dip the seedling stem and tops in an insecticide. Further explanation is found in Unit 15.

2. **Direct seeding**

This method is currently being used by some forest industries and a limited number of smaller landowners. It has the advantage of being considerably cheaper than planting. Many fine stands of pine have resulted from this method when used under suitable conditions. Some serious disadvantages must also be carefully considered before deciding to direct seed. The hazard or risk of failure is considerably greater than for planting, since a successful stand of reproduction requires much more exacting weather and soil conditions. Delay due to failure of the new stand can often result in the loss of site conditions created at a relatively large investment per acre. An additional factor of importance is that even if a successful stand of reproduction is secured, the possibility exists that the seedlings may be too dense for good growth. All possibilities should be considered and the best qualified advice sought before reaching a decision.

a. **Source of seed for planting**

Pine seed can be secured from the commercial seed companies or from personal collection.

b. **Seed treatment**

For success in direct seeding, the pine seed used must be treated with certain chemicals to repel rodents and birds. Usually this can be done by the seed seller for small additional charge.

c. **Tools used**

(1) Cyclone seeder: Regular hand seed sowers can be adapted for use with pine seed. Care must be used to limit seed flow, since only one pound of seed is recommended per acre.

(2) Airplane and helicopter seeding: Large, widespread tracts of hundreds of acres can be seeded in a very short time. Here, too, care and planning must be exercised if seed is to be properly spread. Usually 3/4-pounds to 1-1/2 pounds of seed are used per acre.

Unit 8- Surveying the Forest

TASK ANALYSIS:

Performance Objective

Given access to a tract of timber, determine the area of the tract to the nearest hundredth of an acre with 95 percent accuracy.

Enabling Objectives

1. Define surveying.
2. List the purposes of surveys.
3. Take accurate field notes.
4. Identify and use surveying equipment correctly.
5. Determine location of points on a land surface.
6. Run a closed traverse.
7. Determine area of a closed traverse.
8. Use Reddi Mapper to determine area.

Criterion-Referenced Measure

Determine the area of a forest tract to the nearest hundredth of an acre with 95 percent accuracy.

Selected Instructional Activities

1. Discuss the types and purposes of surveys.
2. Have students list reasons for accuracy and precision in surveying.
3. Display surveying equipment and explain the function of each instrument.
4. Display samples of field notes and discuss the importance of neatness and accuracy in these records.
5. Have students work problems requiring conversion from one basic unit of length to another, e.g., acres of miles to chains.
6. Arrange demonstration of and have students participate in the surveying of a particular forest tract which includes both level ground and slope.
7. Demonstrate and have students run a closed traverse and determine the area of the traverse.
8. Demonstrate and have students practice using a Reddi Mapper.

Selected Tools and Materials

Field note forms
Steel tapes
Surveyor's tape
Compass
Abney level
Planimeter
Reddi Mapper

Selected Audiovisual Materials

Topographic maps
Aerial photographs

Selected References

Elementary Forest Surveying and Mapping. Robert L. Wilson.
Elementary Surveying. Russell C. Brinker and Paul R. Wolf.
Forest and Forestry. David A. Anderson and William A. Smith.
Forest Measurements. Eugene T. Avery.
Fundamentals of Surveying. Milton O. Schmidt and William H. Rayner.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. Surveys are performed for several different purposes, but the primary reasons for surveys of forest land are to determine boundaries of tracts and to determine the acreage of a given piece of forest land.
2. Harvesting operations are often arranged with approximate descriptions of the woods to be cut. To protect the forest owner and logger, exact boundaries should be established. The most precise method of determining boundaries is by survey.
3. It is essential in effective forest management to know the acreage of tracts to be used, improved, or harvested.

B. General situation

1. Land is sometimes bought and sold without reference to its actual location on maps or aerial photographs. The same lack of specificity often applies to forest products.
2. Boundary disputes often arise between neighbors and municipalities.
3. Surveys, used alone or in conjunction with existing maps and aerial photographs, are performed to solve problems arising from inexact descriptions or boundary disputes.
4. Surveys are used to create and update maps, to locate roads, and to determine land configurations.

C. Local situation

1. Determine if any students (or their families) have had their land surveyed; if so, find out the purpose of the survey.
2. Determine if there is new road construction underway in the local area, and point this out as an example of the use of surveys.
3. Review elements of map and aerial photograph interpretation before embarking on a study of surveying.

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

A. Arrange a field trip so students can observe a survey crew in action.

B. Arrange access to a tract of forest land and have groups of students survey the tract by running a closed traverse.

1. Have selected students prepare field notes.
2. Have students compute the area within the closed traverse by using one or more methods (cross-section squares, triangulation, or by planimeter).

C. Have students make and use a Reddi Mapper.

IV. EVALUATION

A. Partipation as survey crew member

B. Determination of acreage to nearest hundredth of an acre (95 percent accuracy required)

FOREST SURVEYS

II. PRESENTATION

A. Definition of surveying

Surveying is the art of location of points of lines on or near the surface of the earth by measuring angles, directions, and distances.

B. Types and purposes of surveys

1. Control surveys determine horizontal position and elevation.
2. Topographic surveys determine ground configuration.
3. Surveys determine the direction and length of lines.
4. Boundary surveys determine the position of property lines and enclosed areas.
5. Construction surveys determine the position of buildings, roads, dams, etc.

C. Accuracy and precision

Regardless of the type of survey, a good surveyor must produce accurate and precise results. Before starting any survey, the surveyor or forester must decide on the accuracy desired for a project (usually based on cost). Many forestry applications do not require precise instruments; for example, less precise instruments such as a compass to measure angles and directions, taping or pacing to measure horizontal distances, and an abney level or clinometer to measure differences in elevation and vertical heights are satisfactory for many surveys. If greater accuracy is desired, more precise instruments such as transit or theodolite to measure angles, directions, or elevations and a steel tape with temperature and tension corrections to measure distances are often used.

This unit will concentrate on the use of less precise instruments that are much simpler and faster to use, but still provide the required accuracy for many forest surveying situations.

D. Field notes

Field notes are permanent written records of surveys taken at the time the work was done in the field.

To prevent redoing, field notes must be neatly and clearly written so that anyone can easily read and interpret them. Field notes usually consist of numerical values, sketches, and explanatory notes, such as those shown in Figure 8-1.

II. D. (Continued)

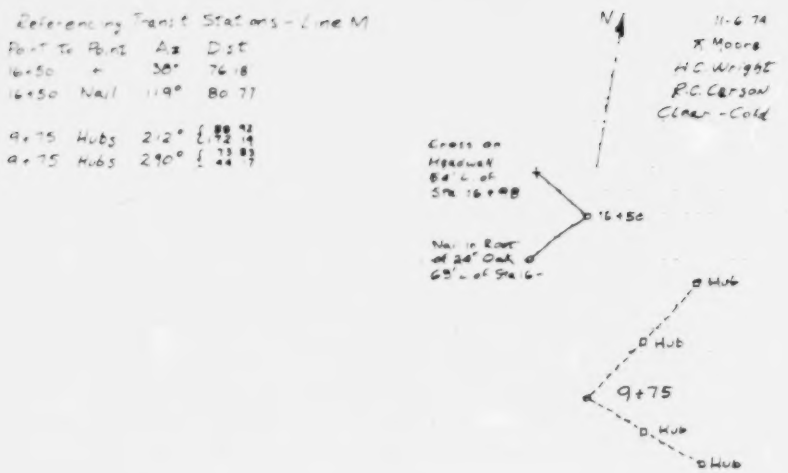


Figure 8-1. Sample Note Form

Some common abbreviations and symbols used in field notes are listed below:

Sta.	station	H.S.	head chain
H.D.	horizontal distance	R.C.	rear chain
S.D.	slope distance	C.C.	crew chief
D.E.	difference in elevation	C.P.	chief of party
T.N.	true north	B.M.	bench mark
M.N.	magnetic north	T.P.	turning point
∠	angle	△	triangulation station
Defl. ∠	deflection angle	H.I.	height of elevation of instrument
Vert. ∠	vertical angle	T.	township
Az.	azimuth	R.	range
Brg.	bearing	Sec.	section
Mg.	magnetic bearing	Sec. Cor.	section corner
Elev.	elevation	¼ Sec. Cor.	¼ section corner
Int. ∠	interior angle	W.M.	Willamette Meridian
Calc. Brg.	calculated bearing	℄	center line
Mg. Decl.	magnetic declination	H. ⚑	head flag
F.S.	foresight	R. ⚑	rear flag
B.S.	backsight	⊙	transit station
Comp.	compass	⊼	transit or level

II. E. Measurement of horizontal distances

1. Units of length

The basic units of length used in the United States for forestry applications are the foot (ft.), meter (m) and the surveyor's or Gunter's chain measuring 66 feet. The foot is used in English-speaking countries and the meter has become the adopted unit for international and scientific usage.

For foresters, the chain is a convenient and popular dimension of horizontal measurement. The unit of land measurement is the acre, (standardized at 1/8 mile (660 feet) in length and 1/80 mile (66 feet) in width. When using a 66-foot chain, an acre becomes 10 chains long and 1 chain wide, or 10 square chains in area. Areas expressed in square chains can be easily coverted into acres by dividing by 10.

Listed below are the equivalents of the different units.

1 mile = 5280 feet = 1760 yards = 320 rods = 80 chains.

1 chain = 66 feet = 4 rods.

1 meter = 39.37 inches = 3.2808333 feet = 1.0936111 yards.

1 acre = 43,560 square feet = 10 square chains.

2. Instruments and methods

Measurement of horizontal distances is essential to the inventory forester, who often must retrace old property lines, survey new tract boundaries, or determine land areas. Distances can be determined by several means, but pacing and measuring with steel tapes are the methods most often used.

a. Steel tapes

(1) Engineer tapes are made of metal and come in 100-, 200-, 300-foot lengths. Most tapes are graduated at every foot, with the first and last foot subdivided in 1/10- or 1/100-foot for measurement of fractional distances. Engineer tapes also can be further divided into adding and subtracting tapes, which have extra graduations beyond the zero mark. When using an adding tape, the fractional part is added on to the measurement held by the rear chainer. With a subtracting tape, the fractional part held by the head chainer is subtracted from the measurement held by the rear chainer.

(2) A surveyor's tape (or Gunter's chain) is also a steel tape, but with different graduations. Generally 2 chains or 132 feet long (plus trailer), the tape is divided into links which are 1/100 of a chain (0.66 feet or 7.92 inches).

II. E. 2. b. **Pacing**

Pacing is the least accurate method for distance measurement, but accurate pacing is a valuable asset to the timber cruiser working alone. Pacing is commonly defined as the average length of two natural steps. For best results, a natural walking gait is recommended because it can easily be maintained under rough terrain conditions. Pacing uniformly is difficult in hilly terrain because slope distance rather than horizontal distance is being measured. When pacing uphill or downhill, compensations for slope must be made by adjusting or skipping a pace at certain intervals.

For instruction in pacing, a horizontal course (5 to 10 chains) should be measured and staked out on level ground. After establishing a consistent gait, the student should pace the measured course several times until an average number of paces per chain can be determined.

c. **Measuring level ground with steel tapes**

Accurate measurement (also called chaining or taping) of distances with a steel tape requires a two-person survey crew consisting of a head chainer and a rear chainer. On level ground, chaining is a simple operation using 11 chaining pins and a steel tape. Beginning at the point of origin, a chaining pin is placed after the "zero" point and the head chainer moves ahead with the remaining 10 pins. When the end of the tape approaches, the rear chainer shouts out, "Chain!" Both crew members pull the tape taut until the rear chainer calls out, "Stick!" After marking the point with a pin, the head chainer replies, "Stuck!" The procedure is repeated until the desired measurement has been taped. As chaining proceeds, the rear chainer keeps the head chainer on a straight course and also collects the chain pins until a 10-chain interval has been measured.

d. **Measuring slope with steel tapes**

In rough and mountainous terrain, horizontal distances may be measured by either keeping the tape horizontal or by measuring the slope distance and then applying a correction to determine the horizontal distance. The first method is called "breaking chain" because only short sections of the tape are used to maintain and measure a level line.

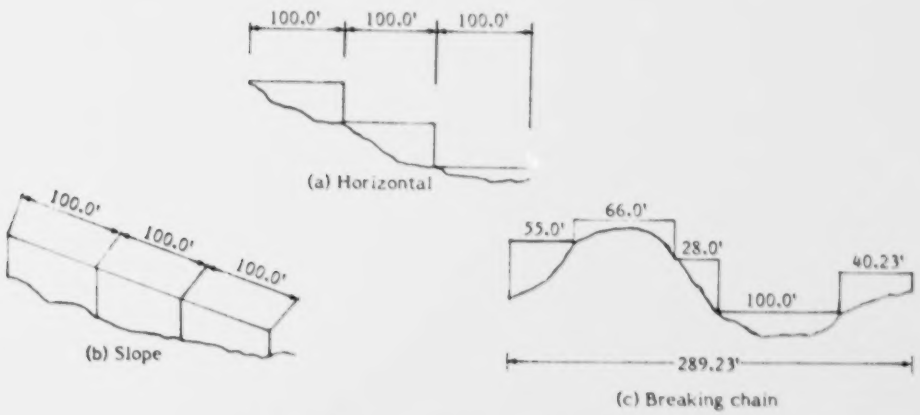


Figure 8-2. Methods of Chaining

II. E. 2. d. (Continued)

For measurement of steeper slopes, foresters often use a 1- or 2-chain trailer tape and an abney level with a topographic scale graduated in percentages of 66 feet. The head chainer moves up or down the slope until the full length of the tape is reached. The rear chainer determines the slope percentage (using the abney level) between his or her position and the head chainer's. Using the slope percentage correction table (or slope correction graduations on the tape), a correction adjustment is made by adding the proper number of links from the trailer tape. The tape is again stretched tight, a new pin is set, and the correct horizontal distance is marked and recorded.

F. Measurement of direction

A fundamental purpose of surveying is to determine locations of points on the land surface. In order to fix the position of a point, angles and directions, as well as distances, must be determined. Horizontal angles are the basic measurements for determining bearing and azimuths.

1. Bearings

The use of bearings is one system of representing directions of lines. The bearing of a line is the acute horizontal angle between it and a reference line (meridian). The angle is always measured from north and south to east or west, dividing the circle into quadrants of 90 degrees each. Bearings never exceed 90 degrees and are always referenced to one of the quadrants of the compass (NE, SE, SW, NW) (See Figure 8-3).

2. Azimuths

Another system of designating directions is the azimuth, which varies from 0 to 360 degrees. An azimuth is the angle a line makes with the true north-south line (meridian) and is always measured in a clockwise direction from due north.

The relationship between bearings and azimuths can be seen in Figure 8-4. Azimuths are generally true or magnetic, depending upon the meridian used.

II. F. 2. (Continued)

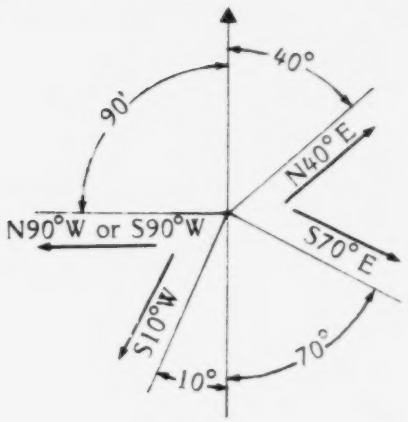
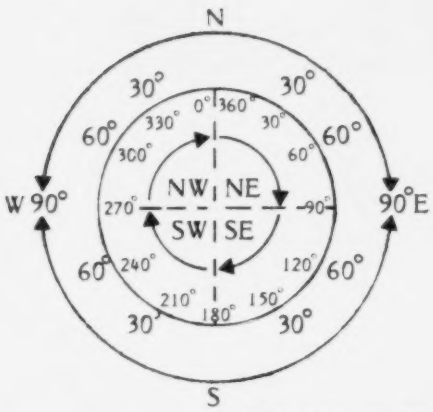


Figure 8-3. True Bearings



ASIMUTH - INSIDE CIRCLE
BEARING - OUTSIDE CIRCLE

Figure 8-4. Relationship of Bearings and Azimuths

3. **Magnetic declination and local attraction**

The angular difference between magnetic north and true north is called declination. Because the earth acts like a magnet, corrections are necessary (for either east or west declinations) to compensate for compass distortions caused by the earth's magnetic field. The amount of magnetic declination changes from place to place and from year to year. Isogonic charts are issued periodically and used to determine exact declinations. (See Figure 8-5.)

Compass readings used in establishing and retracing property lines are generally recorded as true bearings or azimuths. Therefore, adjustments for magnetic declination can be made by setting the correct allowance directly on the compass. As long as the declination does not change, all compass readings will be in true bearings (and azimuths) rather than magnetic.

Other local magnetic attractions may also cause a compass to read incorrectly. When surveying is being done near ore and mineral deposits, fence lines, or electrical transmission lines, care must be taken to keep these "local attractions" from affecting compass readings.

II. F. 3. (Continued)

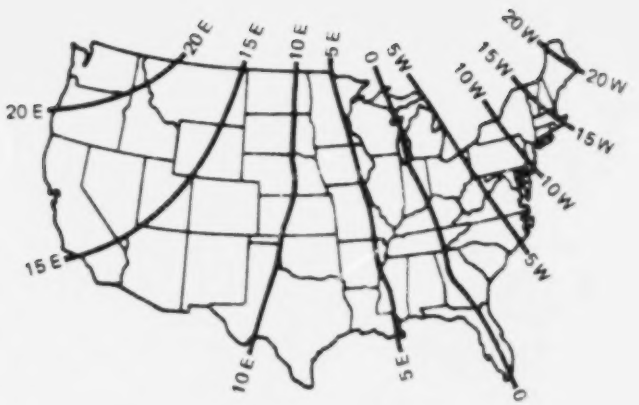


Figure 8-5. Lines of Declination in the United States

4. **Instruments and use**

For most forestry applications, the compass is still the main instrument used for angle measurements. A compass consists of a magnetized steel needle (which points toward magnetic north), mounted on a pivot at the center of a circle which is graduated in one-degree units. There are many types and brands of compasses, but foresters commonly use either the hand compass or the staff compass.

a. **Hand compass**

The hand compass is held with both hands about chest high. Bearings are determined by sighting along the desired line through a notched site in the compass box. The bearing of the line is then determined by reading the degrees shown on the compass dial when the needle and the orienting arrow correspond. A viewing mirror aids in sighting the bearing line and turning the compass dial simultaneously.

b. **Staff compass**

A staff or surveyor's compass is a box compass very much like the hand compass (see Figure 8-6), but instead of being hand held, it is supported by a wooden "Jacob's" staff (or tripod). The staff is placed firmly in the ground and the compass box is attached and leveled, using a circular leveling vial. The compass also has a device for clamping the needle securely (for transporting) and an exterior screw for changing the declination. Bearings are determined by sighting through two vertical sighting vanes which are aligned on the north-south axis. Direct readings of bearings (in degrees or half degrees) are shown on a circular scale at the outer rim of the compass box. Accuracy of the staff compass, when used in conjunction with a steel tape, is approximately 1/300. (For more exact surveys where greater accuracy is required, a vernier transit should be used.)

II. F. 4. b. (Continued)

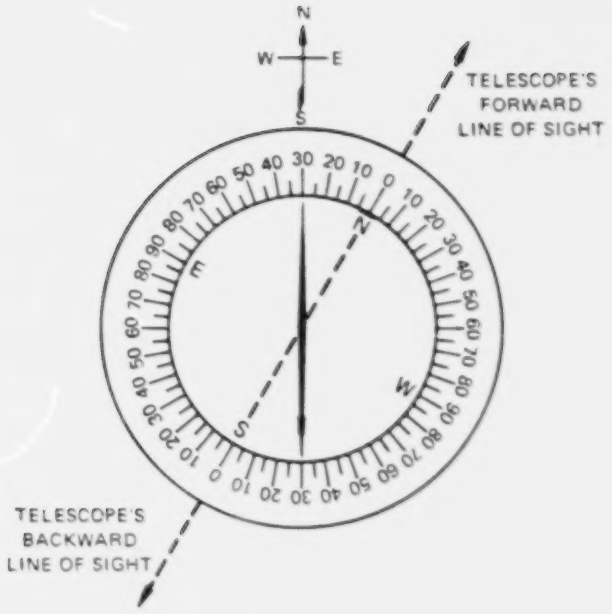


Figure 8-6. Staff Compass Box

G. Boundary surveys and traversing

1. Boundary surveys

Foresters survey the boundaries of a timber tract to establish exact property lines, to locate timber-cutting areas, and to determine the area of a tract. Occasionally, land surveys are used to locate fences and firebreaks; to plan for logging roads, skid trails, and log loading areas; to locate water drainages, culverts, and bridges; and to map timber types, soil series, watersheds, or recreational areas.

2. Traversing

A survey or traverse is defined as a "series of consecutive lines whose lengths and directions have been determined by field measurements." There are two basic types of traverses: closed and open. A closed traverse begins and ends at the same point and forms a closed polygon of an undetermined area. An open traverse generally begins at a known point and consists of a series of connected lines that terminate at an unknown position.

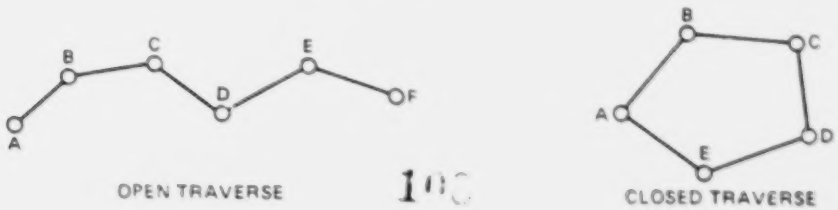


Figure 8-7. Open and Closed Traverses

II. G. 3. Method of running a traverse

Most boundary surveys or closed traverses require a three- or four-person crew. The crew generally consists of a party chief who serves as a compass operator and notekeeper, two people who chain horizontal distances, and the fourth person who handles the range poles at each compass setup.

Beginning at a known corner (A), the surveyor's compass is set-up and a compass bearing (foresight) is made to the next corner (B). The compass operator records the foresight (nearest degree) and the two chainers tape the distance between points A and B. At point B, the compass is again set up and a bearing reading back to point A is taken. This is termed a backsight and is used to check for local attraction and accuracy of the foresight. The survey from point B to point C and other points in the traverse are made in the same way as from A to B. All foresights, backsights, and distances are recorded in the field notebook, as shown in Figure 8-8. Normally, the fourth person in the survey party places a range pole at each point, which acts as a temporary marker until a wooden stake can be driven into each corner station. Each traverse station is designated as A, B, C, D, etc.

Closed Traverse with Side-Shots @ E & F

Sta	Defl L	Bearing	Slope D	Vert L	Hor D
A	F 20°10'R	N39½E	F 223.14	-6°10'	221.85
	B 40°20'R	S39½W	B 222.44	+4°14'	221.83
	20°10'R	N39½E			221.84
B	D 102°28'R	N60°E	D 350.30	+3°26'	349.67
	F 204°56'R	S60°W	B 350.93	-4°57'	349.63
	102°28'R	N60°E			349.65
C	67°31'L	S17½E	287.62	-5°11'	286.44
	135°02'L	N17½W	287.05	+3°45'	286.44
	67°31'L	S17½E			286.44
D	129°23'R	S84½E		—	87.33
	258°46'R	N84½E		—	87.32
	129°23'R	S84½E			87.32
E	39°54'R	S47½W	171.61	-2°18'	171.47
	79°48'R	N47½E	171.50	-1°02'	171.47
	39°54'R	S47½W			171.47
F	58°22'R	S85W	424.88	+3°21'	424.15
	116°44'R	N85E	424.46	-2°19'	424.11
	58°22'L	S85W			424.13
G	77°11'R	N36½W		—	126.70
	154°22'R	S36½E		—	126.72
	77°11'R	N36½W			126.71
A					
E-M		N5°E			20.4
F-N		N38½W			18.6

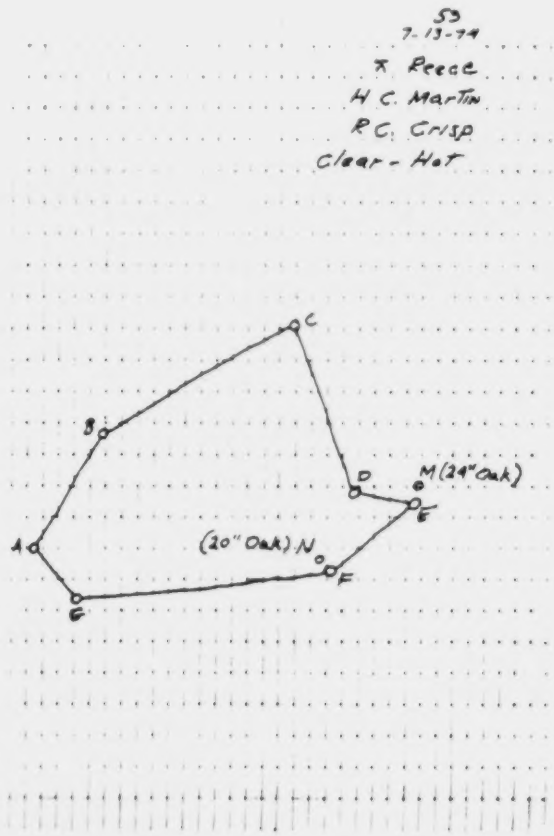


Figure 8-8. Field Notes and Plotted Area for a Closed Traverse

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II. G. 3. (Continued)

After the traverse is complete, the interior angles and distances should be plotted on standard cross-section paper. If the bearings have been properly taken, the sum of all interior angles should equal (n-2) 180°, where n is the number of sides in the traverse. After the interior angles are checked, the traverse should be plotted at a convenient scale. If the horizontal distances have been chained correctly, the plotted traverse should appear to "close."

H. **Determination of area**

After the closed traverse is plotted, several methods can be used to compute the area included with the survey boundaries.

1. **Cross-section squares**

Assuming the traverse is plotted correctly, the enclosed area can be determined graphically by computing the area of the small squares found on the cross-section paper. The total acreage can be easily found by counting all the small squares enclosed within the plotted traverse.

2. **Triangulation**

Most tracts can be divided into triangles by connecting the various plotted points. Having done this on the plotted traverse, the area of each triangle is computed by the formula s = 1/2 (a + b + c). The sum of all the areas of the triangles is the total tract area.

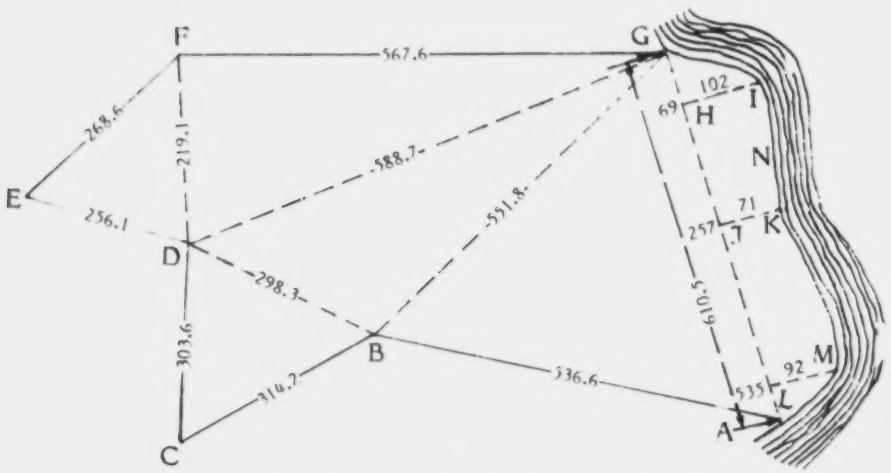


Figure 8-9. Area Determination by Triangles

II. H. 3. Planimeters

Polar planimeters are instruments used to trace the outline of the plotted traverse area. As the boundaries are traced, the planimeter mechanically records the area in square inches and is read directly from the vernier scale. With this information, the total area of the traverse can be determined by converting the square inches to the scale of the map.

4. Reddi Mapper

This is a very simple, inexpensive tool to use. It can be made or purchased. The azimuth (compass) portion can be tracing paper or plastic material that will accept pencil marks. The azimuth degrees are printed around the outside edge of a 12- to 14-inch piece of transparent plastic or paper. Some book stores sell paper with the azimuth printed in the margin. The exact center is noted.

This unit is then mounted on a piece of hardboard on which is glued cross section paper (10 lines to the inch). The center of the hardboard should have a pin or nail. The plastic unit is then centered on the nail. The top center line (directly above the nail) on the graph paper is marked north. This is the orientation point to use when recording the compass reading and distance.

To use the Reddi Mapper system, all that is needed is a pencil, ruler, compass, and knowledge of pacing.

The surveyor selects the starting point, estimates the area, chooses a scale so that the map will fit on the plastic sheet, and takes a compass reading from A to B. The distance from point A to point B is paced and the plastic sheet is pivoted on the nail until the azimuth reading on the plastic reads the same as the compass reading over the north mark at the top of the board. The distance is then drawn on the plastic to scale. The points are marked A and B, with the compass reading and distance recorded in a notebook.

The surveyor then moves to point B and gets the compass reading and distance to point C. The plastic is pivoted until the azimuth reads the same as the compass reading, always orienting the azimuth (compass reading) with the orienting north mark on the graph paper. The surveyor then follows the same process to the next points. Eventually the traverse closes.

The final task is to determine the area in the traverse, by the cross-section squares method.

Unit 9– Measuring and Marketing Forest Products

TASK ANALYSIS:

Performance Objectives

1. Given a written set of dimensions, the actual pulp sticks, or a standing tree and necessary tools, calculate the volume of pulpwood. Answer must be within ±5 percent of instructor's calculations.
2. Given access to a tract of land and necessary tools and materials, estimate the volume of standing timber for that tract. Answer must be within ±5 percent of instructor's calculations.
3. Given a description of a forest tract, develop a plan for marketing which includes determination of products to be sold, market selection, marketing method, and a written sales contract. Plan must be rated acceptable according to instructor-provided checklist.

Enabling Objectives

1. Define terminology associated with measurement of pulpwood and standing timber.
2. Identify and demonstrate use of tools for measuring stacked and standing timber.
3. Perform mathematical computations used in measurement of timber and demonstrate conversion to measure desired.
4. Explain the process by which the volume of a tract of standing timber is estimated.
5. Identify markets available in the local area.
6. Explain the factors which influence the sale of wood products (what to sell, when to sell, and how to sell).
7. Identify and describe the common methods of marketing timber.
8. Identify and define the types of bids.
9. Identify the components of a written timber sale contract.
10. Identify logging byproducts that may be marketed.

Criterion-Referenced Measures

1. Calculate the volume of pulpwood from a set of dimensions, actual pulp sticks, or a standing tree to within ±5 percent of instructor's determination.
2. Calculate the volume of standing timber on a given tract of land to within ±5 percent of instructor's determination.
3. Develop a marketing plan for forest products on a selected tract of forest land which includes descriptions of the products sold, market selection, marketing method(s), and written sales contract(s), to be evaluated according to instructor-provided checklist.

Selected Instructional Activities

1. Have students define key terms related to measuring and marketing forest products.
2. Display and demonstrate how to use tools for measuring lumber and standing trees and how to use measurement conversion chart.
3. Demonstrate and have students practice mathematical computations involved in timber measurement.
4. Demonstrate how to use the Biltmore stick to measure the merchantable height of standing timber.
5. Discuss the types of forest products most in demand in the local area.
6. Discuss the relative market value of various wood products.
7. Discuss the ways standing timber and felled trees may be marketed.
8. Display and discuss samples of bids and contracts.

Selected Tools and Materials

Case study data or pulp sticks for measurement
Instructor-provided checklist for market plan evaluation
Steel tape measure
Biltmore stick (with Merritt Hydrometer scale)
Tree calipers
Measurement conversion charts (volume tables)
Samples of bids and contracts
Projector (filmstrip) and screen

Selected Audiovisual Materials

Filmstrip: Measuring and Marketing. Vocational Agriculture Filmstrip No. 8, Virginia Forest Series (#10750). Audiovisual Services, Virginia Department of Education.

Selected References

Forestry Handbook. Ronald Press Company.
Forestry in the South, Chapters 16 and 17. M. D. Mobley and R. N. Hoskins.
Managing the Small Forest. USDA Farmers' Bulletin No. 1980.
Patterns for Preservation--A Conservation Text. David Tillotson.
Southern Forestry. Charles N. Elliott and M. D. Mobley.
Tables for Measuring Timber. Virginia Division of Forestry Publication No. 58.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. The profitable growth and marketing of products depend on a knowledge of the units of measurement used, how the measurements are obtained, and how they are best utilized in sales negotiations.
2. Cordwood is sold using several different units of measurement (the 128 cubic-foot "standard cords," the 180 cubic-foot unit, and by weight).
3. Sawtimber is sold in units of 1000 board feet, estimated by different log rules, by mill run, by the boundary, and by the weight.
4. Timber may be sold at auction or by sealed bid.
5. A written contract should be drawn up for each sale stating the terms of the sale and any limitations on the buyer.

B. General situation

1. Many forest landowners sell forest products without knowing the value or quantity of the product.
2. Units of measurement may be misunderstood; the buyer might be thinking of a 180 cubic-foot unit and the seller of a 128 cubic-foot cord.
3. The terms of a timber sale are often discussed verbally and no written agreement is made.
4. Boundaries are not always clearly marked, and selling timber by the boundary may result in litigation.

C. Local situation

1. Determine if any students have timber of saleable size on their property; if so, if it is sold and for what products, and how it is measured or estimated.
2. Determine if students are familiar with the units of measurement used in marketing products such as pulpwood, excelsior, piling, poles, sawtimber, and fence posts.

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

A. Have each student make a Biltmore stick and practice using it.
B. Arrange a field trip to a site where each student participates in the step-by-step operation of measuring and estimating timber.
C. Select one group of trees sized for sawtimber and one sized for pulpwood. Have students estimate the volume.
D. Arrange a field trip to a wood-using industry such as a pulp company, sawmill, or excelsior plant, so students can observe raw materials being converted into usable products. Have them observe the actual volume cut from a log measured before sawing.
E. Have students develop a marketing plan for a given forest tract.

IV. EVALUATION

A. Calculations determining the volume of pulpwood from dimensions, pulpwood sticks, or a standing tree (±5 percent of instructor's calculation).

B. Calculations determining the volume of standing timber on a given tract (±5 percent of instructor's calculations).

C. Marketing plan for selected forest tract (acceptable according to instructor-provided checklist).

MEASUREMENTS AND MARKETS

II. PRESENTATION

A. Defining units of measurement

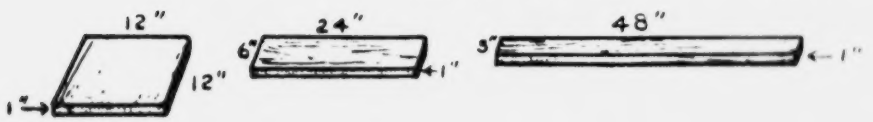
1. Log--a section of the trunk of a tree, usually a minimum of 8 feet in length with a minimum diameter of 6 inches, inside the bark, at the small end.

2. Pulpwood and excelsior bolt--a section of the trunk or larger limbs of a tree 5 feet in length, with a minimum diameter of 4 inches, inside the bark, at the small end.

3. Board foot--unit of measure for lumber; equivalent to a board 1 inch thick and 12 inches square. A board 1 inch thick, 12 inches wide, and 10 feet long contains 10 board feet.

$$\text{Bd. Ft.} = \frac{\text{thickness (inches)} \times \text{width (inches)} \times \text{length (feet)}}{12}$$

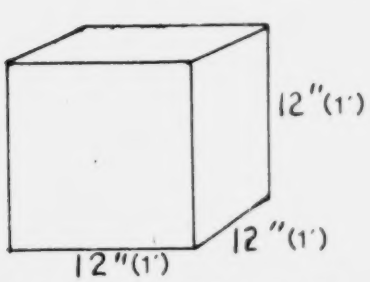
Each piece of lumber contains one board foot.



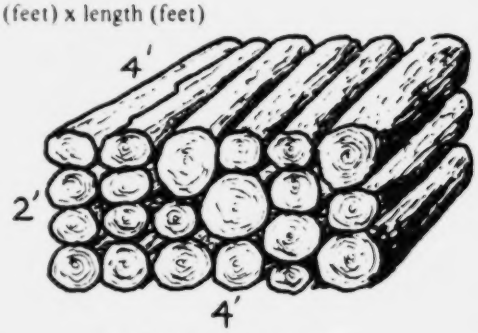
This piece of lumber contains 10 board feet.

4. Cubic foot--unit of measure 12 inches wide, 12 inches thick, and 12 inches long or its equivalent, used to measure cord wood volume.

Cu. ft. = thickness (feet) x width (feet) x length (feet)



Cubic foot = 12" (1') x 12" (1') x 12" (1')



2' x 4' x 4' = 32 cubic feet

II. A. 5. Standard cord--contains 128 cubic feet of unpeeled, stacked wood. This is a stack of wood 4 feet wide, 4 feet high, and 8 feet long.

6. Unit--contains 180 cubic feet of unpeeled, stacked wood. This is a stack 5 feet wide, 4-1/2 feet high, and 8 feet long. The wood is usually cut to lengths of 5 feet.

7. Piece--poles and pilings that are valuable special products. Standards of length, straightness, and diameter determine value. Different standards apply to posts and cross ties, but dimensions and quality determine value.

8. Weight--Most pulp companies buy pulpwood by weight instead of by the cord and unit. The weight used to represent a cord or unit may vary between companies, but will be the average weight per cord determined by measuring and weighing many loads of wood in their particular area. An example of the weights used by one company is as follows:

	Pine	Hardwood
128 cubic feet =	5090 pounds -	5109 pounds
180 cubic feet =	7158 pounds -	7185 pounds

B. **Using log rules**

A log rule is a table showing the estimated or calculated amount of lumber that can be sawed from logs of a given length and diameter. These rules are based on different formulas, or are derived in different ways, so that they do not agree as to the amount of lumber that can be sawed from a log of a given size. The most commonly used log rules are as follows:

1. International 1/4-inch rule--the most accurate of the log rules, recommended for use in the state of Virginia.
2. Doyle Rule--underestimates small logs.
3. Scribner Decimal C Rule--an official rule of the U.S. Forest Service.

COMPARISON TABLE OF LOG RULES

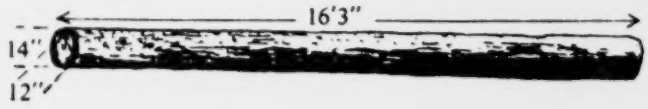
Diameter of Log, Top End (Inches)

Log Length Feet	10"			20"			30"		
	Int.	Doyle	Scribner	Int.	Doyle	Scribner	Int.	Doyle	Scribner
12	45	27	30	210	192	210	495	507	490
14	55	32	40	250	221	240	585	591	570
16	65	36	50	290	256	280	675	676	650
18	75	41	60	330	288	310	765	761	740

II. C. Measuring logs

Pine and hardwood sawlogs are cut to the nearest even foot (8-, 10-, 12-, 14-, 16-foot logs, etc.), allowing an extra 2 to 4 inches for trimming. Use the following procedure in measuring logs:

1. Measure the average diameter of the small end of the log in inches, inside the bark. Take at least two measurements to compute the average diameter.



2. Measure the length of the log to the nearest even foot. Drop all fractions but allow 2 to 4 inches for trimming. For instance, a log measuring 9 feet 10 inches would be an 8-foot log.

3. Deductions must be considered for crook, decay, or other defects. This can usually be handled by adjusting the scaling diameter.

4. Use Virginia Division of Forestry Publication No. 58, Tables for Measuring Timber, to determine the volume in the log from the Log Scale. For example, the volume of the log illustrated above would be 115 board feet.

Log Scale
International Rule ¼ Inch Kerf

Diameter of Log Small End (inches)	Length of Log (Feet)				
	8	10	12	14	16
	Volume in Board Feet				
8	18	22	25	35	40
9	22	30	35	45	50
10	30	35	45	55	65
11	35	45	55	70	80
12	45	55	70	85	95
13	55	70	85	100	115
14	65	80	100	115	135
15	75	95	115	135	160

II. C. 5. In measuring and tallying a load of logs, it is best to use the following tally system: A similar tally sheet may be designed for standing timber measurement.

Tally Sheet for Sawlogs

Diameter of Log Small End inside Bark (Inches)	Number of Logs by Length in Feet					
	8	10	12	14	16	18
6						
7						
8	(4)					
9	(5)				(7)	
10						
11					(8)	
12						
13						
14						

The tally system is as follows:

6. The total volume is computed by multiplying the number of logs in each size class by the board feet in one log of that size. Thus, 4 logs, 9 inches d.i.b. (diameter inside bark at small end) and 8 feet long contain 22 (board feet in one log) x 4 logs of this size = 88 board feet.

D. Estimating standing timber (board feet)

It is somewhat more difficult to estimate the volume in a standing tree than in a log. A number of tools may be used, but a Biltmore stick is all that is necessary.

1. The Biltmore stick

This measuring device has three graduated sides that are used to measure diameter and height. The fourth side is the Scribner Decimal C Log Rule, which will not be used.

a. Biltmore stick side is used to measure diameter at breast height, which is 4-1/2 feet from the ground.

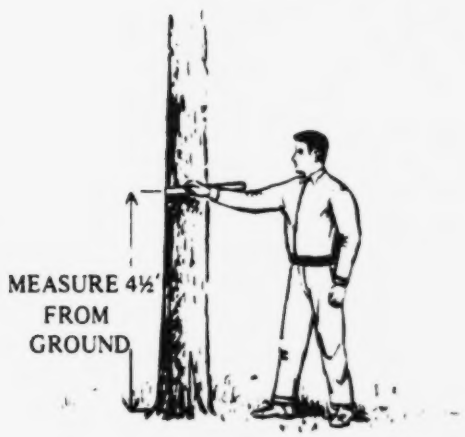
II. D. 1. b. Merritt Hypsometer side is used to determine merchantable height in terms of 16-foot logs.

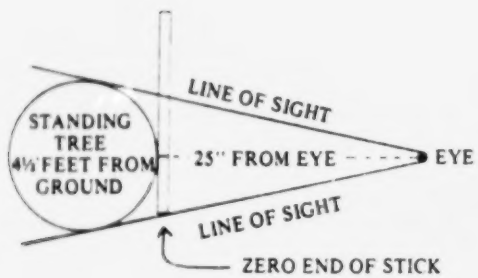
c. Yardstick side is used to measure small end of logs for diameter and/or the length of the log.

2. **Standing tree volume determination**

To determine the volume of a standing tree, two measurements must be determined. The first is the diameter at breast height, and the second is the merchantable height of the tree to the nearest one-half log. Merchantable height is usually up to a 6-inch top diameter for pine and 8-inch diameter for hardwood. A log is 16 feet long, and one-half log is 8 feet long.

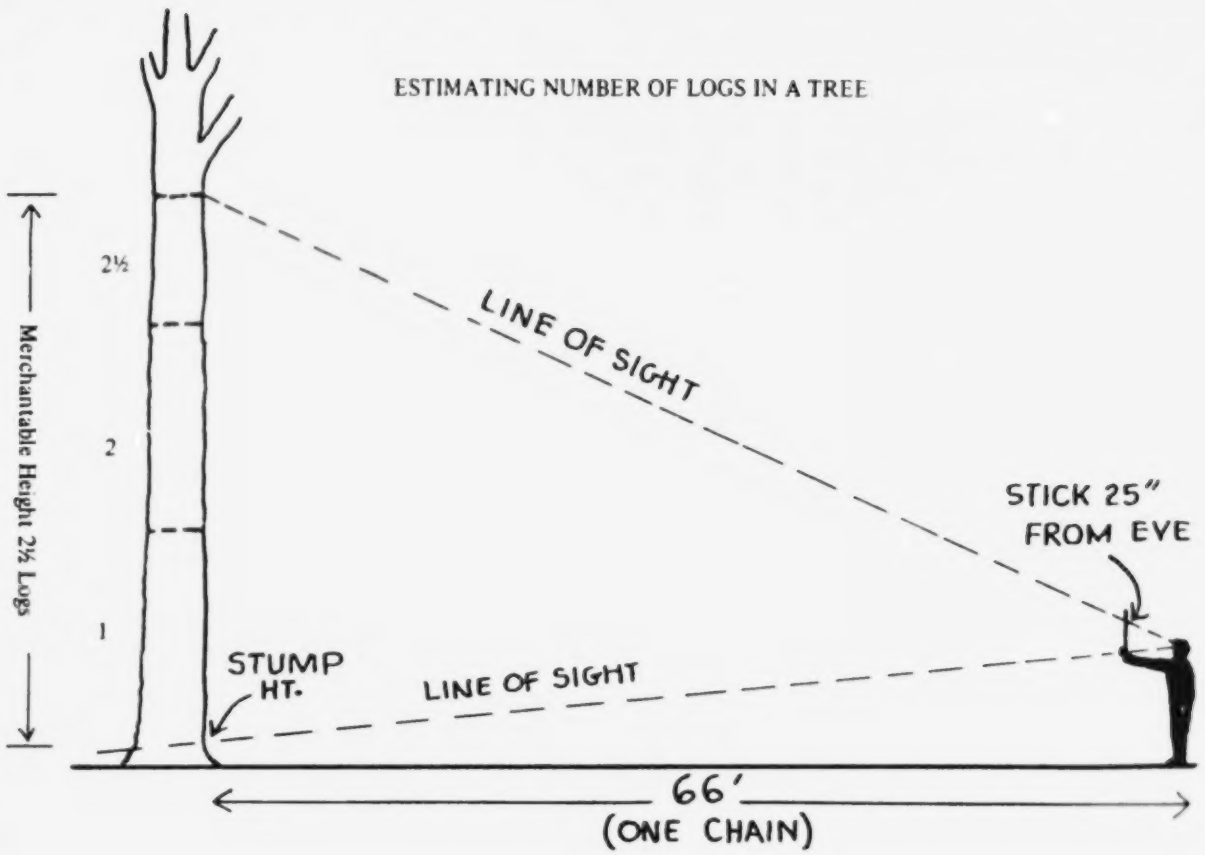
a. To measure diameter, hold the Biltmore stick horizontally, 25 inches from the eye. With stick against tree, 4-1/2 feet from the ground, line up left end of stick with the outer edge of the bark. Without moving anything but the eyes, read the nearest graduation on the stick to the other edge of the tree. Take another reading at right angles to this first reading. Average the two readings. This is the diameter of the tree. If one reading is 13 inches and the other 15 inches, the diameter is 14 inches.





b. To measure the merchantable height, use the Merritt Hypsometer side of the stick. Pace or step one chain (66 feet) from the tree. Face the tree and hold the stick perpendicular to the ground, 25 inches from the eye. Line up the bottom of the stick with approximate stump height. Moving only the eyes, read the merchantable height to the nearest one-half log (8 feet). A tree having 2-1/2 logs of merchantable height would have 40 feet of merchantable length.

II. D. 2. b. (Continued)



c. To determine volume, refer to Tables for Measuring Timber, Division of Forestry Publication No. 58. Use the table headed "Tree Scale in Board Feet."

Under the column headed "Diameter Breast High," locate the diameter of the tree to the nearest 2-inch class. Move the finger to the right under the column giving the proper tree height in logs. The figure at the intersection of these two lines of figures is the board foot volume the tree contains.

For example, if the tree is 14 inches in diameter and contains 2-1/2 logs, the volume is 160 board feet.

Tree Scale in Board Feet
International Rule ¼ Inch Kerf

Diameter Breast High (Inches)	Number of 16-Foot Logs						
	1	1½	2	2½	3	3½	4
	Volume in Board Feet						
10	38	50	61	99	77		
12	58	77	96	110	124	132	141
→ 14 →	82	110	138	160	182	196	211
16	108	146	183	214	246	269	292

II. E. Estimating standing timber (cubic feet)

To estimate the number of cubic feet in a standing tree, follow same procedure as in estimating for board feet.

1. Determine the dbh using the Biltmore stick. Determine merchantable height to a 4-inch top in terms of 16-foot logs and convert to 5-foot bolts. (If tree contains two logs to a 4-inch top, this equals 32 feet or six 5-foot bolts to the nearest bolt.

2. Refer to the last page of Virginia Division of Forestry Publication No. 58, to the table headed "Tree Scale for Pulpwood." This will give the volume in cubic feet, including the bark. Use table as is for sawtimber, except that the answer is in cubic feet. If dbh is 8 inches and tree contains eight 5-foot bolts, it has 8.93 cubic feet. After determining the total cubic foot volume of a group of trees, remember to divide the total cubic feet by 90 to convert cubic feet to standard cords (128 cubic feet of stacked wood, including bark, contains approximately 90 cubic feet of solid wood). To determine 180-cubic foot units, divide by 126. For example, a group of trees are measured and tallied. The total cubic feet in these trees is calculated to be 180.00 (180 ÷ 90 = 2 standard cords.)

F. Determining products to be sold

To determine whether a forest site contains salable products, it is essential to know the types of products for which there is a demand, and the comparative values involved.

1. Value

Value is determined by available markets. Markets vary from one locality to another, and consequently the local market situation must be carefully checked.

2. Products (types of markets)

This list covers the more common markets available. However, it is seldom that all of these would be available in any one area of the state.

Sawlogs	Excelsior
Pulpwood	Crossties
Veneer	Posts
Piling	Mine Timbers
Poles	Handle Stock
Cooperage	Fuel Wood

G. Selecting the market

1. What to sell

Products vary materially in their value, and trees should be sold in the product that will yield the best return. Sawlogs will bring more per unit of volume than will smaller products such as pulpwood, excelsior wood, or fuel wood. Large sawlogs, veneer bolts, piling, and poles will bring higher returns than the average sawlog.

II. G. 1. (Continued)

As an example, the following tables illustrate comparative values for pine timber between the International 1/4-inch Log Rule, the Doyle Log Rule, and pulpwood.

The first column of each table represents the tree size (diameter and merchantable height). Table A represents the board foot volume for the International 1/4-inch Rule, and using stumpage values between $50 per MBF and $100 per MBF gives the dollar value of the tree. Table B shows the tree value using the Doyle Volume Tables. Table C shows the standard cord (cubic feet converted to cords) content of the tree and its value at $8 and $12 stumpage.

These tables emphasize the difference in the Doyle and international volume tables, as well as the monetary difference in selling quality-size sawtimber as pulpwood.

COMPARISON OF AVERAGE TREE STUMPAGE VALUES

Table A--Value of Tree (Sawtimber) Using International Rule

Tree Diameter & No. Logs	Board Foot Volume	Stumpage Value		
		$50.00	$75.00	$100.00
12" x 2 logs	92	4.60	6.90	9.20
16" x 3 logs	241	12.05	18.08	24.10
26" x 4 logs	877	43.85	65.78	87.70

Table B--Value of Tree (Sawtimber) Using Doyle Rule

Tree Diameter & No. Logs	Board Foot Volume	Stumpage Value		
		$50.00	75.00	$100.00
12" x 2 logs	43	2.15	3.23	4.30
16" x 3 logs	149	7.45	11.18	14.90
26" x 4 logs	737	36.85	55.28	73.71

Table C--Value of Tree (Pulpwood)

Tree Diameter & No. Logs	Cords	Stumpage Value	
		$8.00	$12.00
12" x 2 logs	.17	1.36	2.04
16" x 3 logs	.41	3.28	4.92
26" x 4 logs	1.36	10.88	16.32

II. G. 2. **When to sell**

The best time to sell any product is when the market for it is high. The timber market fluctuates, as do all markets, and the timberland owner has an advantage in that timber can be held on a low market, and it will continue to add additional growth.

Quite often, farmers find it to their advantage to use their off season labor to cut their own woodlands. This practice is good business, and quite often many products can be harvested and sold by the farmer that might otherwise be lost because a sufficient volume or quantity to interest a commercial cutter is lacking.

3. **How to sell**

The woodland owner has two ways to market forest products. They can be sold as standing trees, or they can be partially processed in such forms as sawlogs, pulpwood bolts, excelsior bolts, and veneer bolts.

These products may be sold on the roadside or delivered to the sawmill, concentration yard, rail siding, or other specified purchasing point.

H. **Choosing method of marketing forest products**

Most timber is sold as stumpage in standing trees. The buyer assumes the responsibility of logging the area, and the owner has no responsibilities except those reserved to him in his contract. These usually refer to supervision to ensure the protection of uncut trees, fences, soil and water resources, and existing roads.

The timber may be sold in several ways:

1. **Lump sum or boundary**
   The timber is sold on a designated area, or on an acreage basis. The timber should always be cruised and an accurate estimate secured prior to the sale.
2. **Mill run or tally**
   The owner receives payment for the timber actually processed, or the pulpwood cut. Care must be taken by the seller to prevent the operator from cutting only the best trees or best portions of the trees, and leaving the remainder in the woods.
3. **Diameter limit cutting**
   The minimum diameter limit of trees that may be cut is specified, such as all trees 10 inches in diameter, 10 inches above ground level. This is usually a very poor cutting practice, since the poorest trees are left for future growth.
4. **Marked basis**
   This is the best method when making partial cuts, as the best trees are left for future growth. Sawtimber is marked and estimated so that the seller knows how much volume is for sale. It is not necessary to estimate pulpwood, since the wood is always measured at the yard or mill.
5. **Log scale**
   Logs are sold on the basis of board foot scale, measured after the trees are felled and cut into logs.

II; H. (Continued)

6. **By the piece**

Speciality products such as poles and piling are sold by the individual piece. These trees are designated by the buyer, and price is determined according to class or grade. Posts and cross ties are also sold by the individual piece.

Felled timber may be sold at the roadside or delivered to the mill by the seller. This is an excellent use for the farmers equipment and "off season labor." If the product is delivered to the mill or yard, the farmer receives a higher price than if the buyer has to pick up and haul the material.

I. **Using bids and contracts**

1. **Bids**

a. **Direct negotiation**

The seller may contact several possible buyers and obtain their best offers, take the highest bid, and make the sale to that bidder.

b. **Sealed bid**

The sale is usually advertised in the local paper, requesting that bids be submitted by a given date and time. The bids are opened at this time, and the sale is made to the highest bidder. However, the right is usually reserved "to reject any or all bids," so that the seller is not forced to accept any bid that does not satisfy predetermined requirements.

c. **Auction bid**

The sale is advertised and scheduled for a given time and place. Interested buyers make their bids and have the chance to raise them as others bid.

2. **Contracts**

Any time the buyer (or the buyer's agent) is to cut the sold timber, a written agreement should be drawn up. The price to be paid, the length of time allowed for removal of timber, and any penalty clauses should be specified and the contract should be properly signed and witnessed. Suggestions for timber sale contracts are included in the Appendix.

J. **Marketing byproducts**

Byproducts are those wood residues left in the woods after a logging operation.

1. **Slabwood**

If not utilized by the operator, it may be marketed in two ways: it may be trucked to a chipper and sold, or it may be marketed as fuelwood. There is a good fuelwood market in many areas. Slabs may be sold in the woods, or the timber owner may cut the slabs in short lengths and sell the wood as fuel or to a stationary chipping operator.

2. **Chips**

The majority of the larger mill operators have portable debarkers and chippers. Slabs, edgings, and small or defective logs are chipped and the chips are sold to the pulp mills. Depending upon the area, both hardwood and pine chips are used.

II. J. 3. **Bark**

Bark may be sold to people interested in using it as a mulch, or in some cases, to a processor who markets ground bark mulch commercially.

4. **Sawdust**

Sawdust is used, in some processes, in the manufacture of charcoal. It is also being used for wood energy. Rotten sawdust makes an excellent mulch, and may be sold for this purpose. Both bark and sawdust may be sold to commercial nurseries.

5. **Fuelwood**

When chippers are used in conjunction with a harvesting operation, very little wood residue remains. However, in normal logging projects quite a bit of material is left that can be sold for fuelwood.

Unit 10—Using Forestry Best Management Practices

TASK ANALYSIS:

Performance Objective

Given access to or a description of a tract of timber and guidelines for loggers and landowners, select and outline the Best Management Practices (BMPs) necessary to reduce erosion and to ensure good quality water. To be rated acceptable, 80 percent of the applicable BMPs for the selected tract must be listed and outlined accurately.

Selected Enabling Objectives

1. List BMPs for woodland access roads.
2. List BMPs for forest harvesting.
3. List BMPs for filter strips.
4. List BMPs related to site preparation, including those for prescribed burning, use of mechanical equipment, and use of herbicides.
5. List BMPs for tree planting.
6. List BMPs for use of pesticides.
7. List BMPs for revegetation of critical forest areas.
8. List BMPs for forest recreation areas.
9. List BMPs for wildlife control and reclamation.

Criterion-Referenced Measure

Select and outline the BMPs necessary to reduce erosion and to ensure good quality water for a selected tract of timber. To be rated acceptable, 80 percent of the applicable BMPs for the selected tract must be listed and outlined accurately, according to guidelines for loggers and landowners.

Selected Instructional Activities

1. Discuss the reasons for implementing forestry BMPs.
2. Invite a forester to discuss how various BMPs can be carried out on the average farm.
3. Arrange field trips to various logging sites and have students list those BMPs they observe in operation.
4. Have individual students or pairs of students choose one BMP and report on it to the class, explaining, why this practice should be carried out, how it is done, and the results to be expected.

Selected Tools and Materials

None identified

Selected Audiovisual Materials

None identified

Selected References

Best Management Practices Handbook--Forestry Loggers Guide. Virginia Division of Forestry.

Forestry Operations That Improve Water Quality. R. H. Hassmen and E. W. Pruett.

Landowners Guide to Best Management Practices. VPI Extension Forester and Virginia Division of Forestry.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. Application of forestry BMPs to reduce erosion and ensure good water quality makes sense from several points of view.
   a. To protect the environment
   b. To protect economic investments
   c. To maintain the balance of nature
   d. To comply with legal standards
   e. To ensure future benefits from the forest and watersheds.
2. Forestry BMPs are a "common sense" approach to effective forest management.
3. Forestry BMPs can be applied by individual forest landowners (on the average farm) as well as by commercial wood-using industries and by agencies administering public forest lands.

B. General situation

1. Virginia is fortunate to have an adequate supply of water. This water comes from streams, springs, and wells, and most of it has its beginning in the forested watersheds in the mountains and foothills.
2. Due to land uses, the water downstream from the watershed often is of poor quality.
3. Poor water quality is a national problem. For this reason, the Federal Water Pollution Control Act of 1972 was passed, stating that all waters of the United States must be swimmable and fishable by 1983.
4. To meet this goal, Virginia instituted a voluntary approach and developed a Best Management Practices program in the areas of agriculture, forestry, mining, urban planning hydrology, and groundwater.
5. There are nine forestry BMPs. Three are generally considered more applicable to loggers and harvesting operations and six are more applicable to landowners. However, all of these practices can be carried out by either.

C. Local situation

1. Determine what logging activities are being done in the local area and what BMPs are being carried out at these sites.
2. Determine if any students who live on farms with timber tracts have ever instituted any of these practices.

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

Arrange a field trip to a timber tract and have students develop a plan for harvesting--laying out log roads and skid trails, locating filter strips, planning site preparation measures, and planning for tree planting after the harvest.

IV. EVALUATION

A. Selection of at least 80 percent of the applicable BMPs for a particular timber tract

B. Accurate outline of those BMPs selected, according to guidelines provided

BEST MANAGEMENT PRACTICES

II. PRESENTATION

A. Forestry BMPs for loggers

1. Woodland access roads and skid trails

Roads and skid trails are necessary for any harvesting operation. A well planned road and trail system will reduce logging costs, reduce amount of mud getting into streams, improve landowner-logger relationships, and keep streams in better condition for fishing and other uses.

a. Locate roads on grades of 2 to 10 percent. A 10-percent grade equals a rise of 10 feet per 100 feet of horizontal distance. To allow for proper drainage, grades of 1 to 3 percent are preferred.

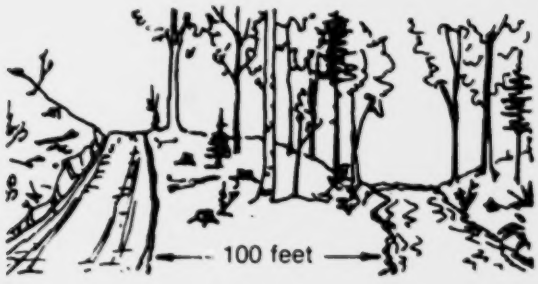
b. Maintain grade by zig-zagging up the hill instead of going straight up.

THIS NOT THIS

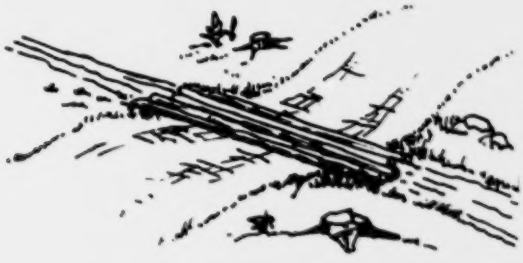
c. Avoid wide, flat ridges for road location. Where possible, locate roads at the edge of a flat ridge for proper drainage.

THIS NOT THIS

II. A. 1. d. Locate roads away from streambeds.



e. When crossing a stream, cross at right angles. Get in and out of the stream area as quickly as possible. Fords should not be used unless there is a hard, rocky bottom and the approaches are rocked to prevent mudholes and mud washing into the stream. If logs are used to make a temporary crossing, they must be removed upon completion of the operation.



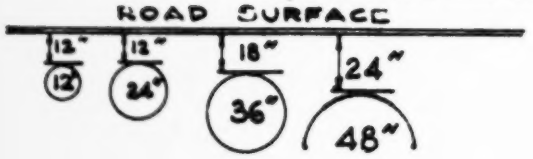
Temporary Crossing

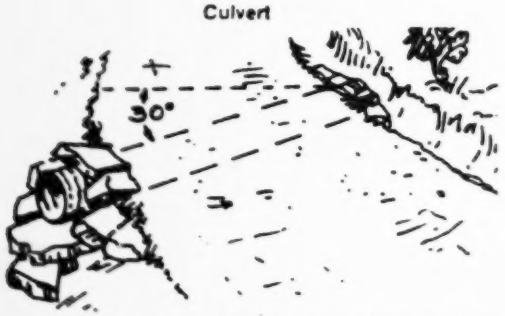
f. Use a low-cost bridge if there are over 200 acres above the crossing. On permanent roads, it is best to use culverts or bridges.

Low cost bridge

II. A. 1. f. (continued)

Culverts must be covered with at least 12 inches of earth fill or one-half of culvert diameter, whichever is greater. Culverts must be long enough to extend full width of road beyond fill. Slope culvert 1 inch for each 4 feet of length for drainage.





Size of Culverts Permanent Roads

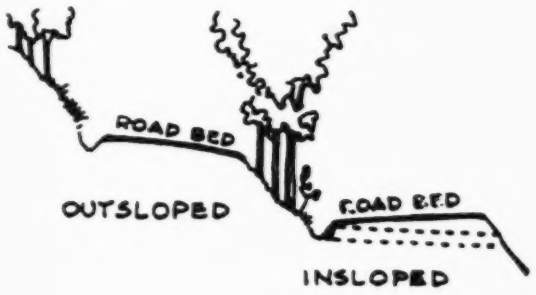
Drainage Area Above Culvert	Coastal Plain	Piedmont	Mountains
acres	inches	inches	inches
10	12	18	21
20	15	24	24
30	21	24	30
40	24	30	36
50	30	36	42
60	36	36	42
70	36	42	48
80	42	42	48
90	42	48	54
100	42	48	54
150	48	54	60
200	48	54	66

g. Make sure that water will drain off the road into undisturbed areas as quickly as possible.

(1) Crown the road and use side ditches.

(2) Outslope the road. This type of road may be hazardous in steep terrain. Level shoulder on downhill side.

(3) Inslope the road and use culverts to drain water to downhill side. Use culvert tables to determine size and frequency.



II. A. 1. h. Use water bars.

(1) Slant water bar downgrade at approximately a 30-degree angle. This can be determined on a road 12 feet wide by having the lower end one big step (3 feet) lower than the uphill end.

(2) Make bar 8 to 12 inches deep.

2. **Forest harvesting**

a. Plan the complete haul road and skid trail system before starting the cutting operation.

b. Construct haul roads and skid trails as described on the previous pages.

c. Leave filter strips between bodies of water and roads, skid trails, landings, and heavily cut areas.

d. Remove all tops and laps from streams.

e. Remove all trash (used oil and containers, radiator damage, hydraulic fluids, filters, etc.) from the cutting site.

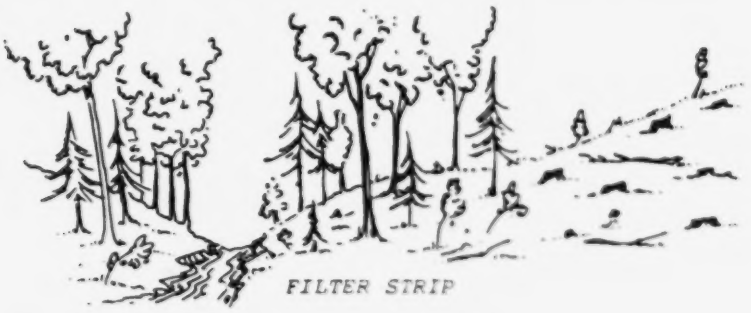
f. Locate landings and log decks on dry sites away from streams.

g. Stablize landings and log yards by seeding immediately after the cutting operation.

II. A. 2. h. In wet lands, plan the drainage system to fit natural drainages, obtain gradual initial discharge into waterways by the use of retention basins and cofferdams, and deposit spoil far enough away from streams and ditches to prevent sloughing.

3. **Filter strips**

a. Use filter strips to reduce amount of soil entering the streams. When reserving a filter strip, consider the following factors.



FILTER STRIP

(1) Land use above filter strip: Bare ground equals high erosion hazard.
(2) Slope of land above strip: The steeper the slope, the higher the erosion hazard will be.
(3) Length of slope: A long steep slope means higher erosion hazard.
(4) Erodability of soil: Clay and fine sand equal higher erosion hazards.
(5) Type of vegetation within strip: Dense vegetation means lower hazard.

Size of Filter

PERCENT SLOPE	WIDTH IN FEET REQUIRED		
	SLIGHT HAZARD	MODERATE HAZARD	SEVERE HAZARD
0	30	40	50
10	55	75	90
20	80	100	130
30	105	140	170
40	130	170	210
50	155	200	250
60	180	235	290

b. The following guidelines apply to filter strips.

(1) Do not construct roads except when necessary to cross a stream. These crossings must be bridges of culverts with stablized banks.
(2) Do not remove more than 50 percent of the trees.
(3) Do not use mechanical site preparation.
(4) Do not use prescribed burning.
(5) Do not use chemicals.

II. B. Forestry BMPs for landowners

Most of these practices can be carried out on the average farm.

1. Site preparation

This practice is in preparation for natural seeding or artificial regeneration (tree planting), and may be accomplished by any of the following methods.

a. Using prescribed burning

(1) Locate fire lines on contours and away from natural drainage.
(2) Keep fire lines as shallow as possible but still effective.
(3) Leave filter strips between fire lines and streams.
(4) Turn fire lines into undisturbed areas; do not run them directly into streams. Complete last 100 feet of line by hand.
(5) Construct water bars to drain fire lines.

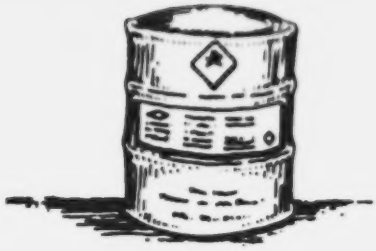
b. Using mechanical equipment

(1) Use mechanical equipment on the contour.
(2) Use a site preparation method other than mechanical on slopes greater than 15 percent.
(3) Use prescribed burning, light bulldozing, root raking, and shear blading in preference to straight blading; expose as little bare ground as possible.
(4) Use drum chopping where practical.
(5) Leave filter strips between site-prepared areas and drainages.

c. Using herbicides

(1) Use herbicides only when this method is clearly the best prescription.
(2) Use only registered herbicides; read and follow label carefully.
(3) Do not spray herbicides in or near streams.
(4) Do not wash or drain containers and spray equipment in streams.
(5) Dispose of herbicide containers properly.

II. B. 1. c. (continued)



2. **Tree planting**

The following guidelines are applicable when planting tree seedlings for any purpose.

a. Plant by hand if feasible.
b. Minimize soil disturbance when using tractor and V-blade with wildland tree planter.
c. Plant on contour when using mechanical tree planter.
d. Use herbicide-type planting machine in open field areas on steep slopes.

3. **Pesticide use**

Follow these precautions when using chemicals to prevent damage by insects, diseases, mammals, or birds.

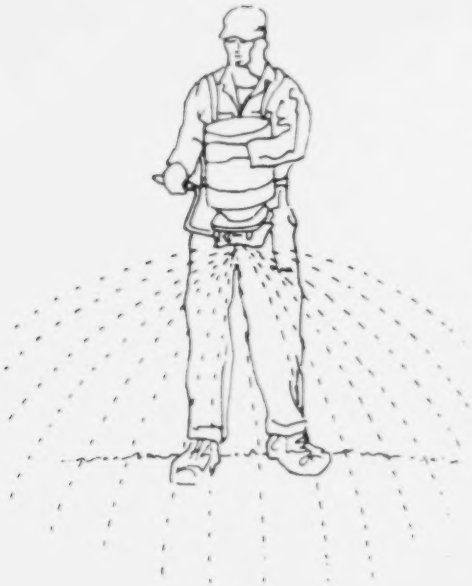
a. Choose correct pesticide and use according to directions on label.
b. Use required safety equipment and clothing.
c. Use pesticides only when weather and atmospheric conditions are favorable.
d. Order no more than one year's supply of pesticide at any one time.
e. Dispose of excess pesticide according to label directions.
f. Follow label directions for container disposal.
g. If a container is to be washed, rinse three times and allow to drain in a vertical position for 30 seconds between rinses.
h. Check label for burning instructions.

4. **Revegetation of critical forest areas**

This practice is to establish a quick vegetative cover on bare areas that are subject to erosion and are likely to become a sediment source area.

a. Prepare seedbed properly by smoothing, disking, and raking.
b. Apply 2 tons of lime and 400 pounds of 10-10-10 fertilizer per acre.
c. Select a seeding mixture from those listed in the seeding table.
d. Use a mulch on highly erodable soils.
e. Protect site from grazing and unauthorized traffic.

II. B. 4. (continued)



SEEDING TABLE

Mixtures	Seeding Mixture Pounds/Acre
Kentucky 31 Tall Fescue	60
Kentucky 31 Tall Fescue Weeping Love Grass	60 2
Kentucky 31 Tall Fescue Sericea Lespedeza	40 20
Orchard Grass	30
Game food mixture may be substituted	

5. **Forest recreation areas**

When forest land is used for recreation purposes, follow these guidelines.

a. Construct roads to specifications outline in section A.
b. Install drainages on foot trails (water bars or turnouts).
c. Reinforce heavily used trails with gravel at critical points.
d. Retain filter strips between parking areas and water's edge.
e. Restrict parking to designated parking areas.
f. Drain parking areas adequately.
g. Reinforce boat ramps to a depth of 30 inches below low water level with gravel or other nonwashing material.
h. Provide a water diversion device between boat ramps and their approaches.
i. Provide sanitary facilities where use is concentrated.

6. **Wildfire control and reclamation**

Follow these guidelines when controlling wildfires and when reclaiming burned areas.

a. Keep fire lines off steep slopes if practical.
b. Avoid drainages when constructing fire control lines.
c. Install water turnouts and drainage ditches on fire control lines once a fire is brought under control.
d. Use hand tools to construct last 100 feet of fire control line before reaching a stream, lake, or other water course. Keep fire control equipment out of streams.

Unit 11—Harvesting Timber Products

TASK ANALYSIS

Performance Objectives

1. Given access to one or more standing trees, desired cutting patterns, chain saw, hammer, and wedges, fell the tree(s) according to cutting patterns and limb and top the felled trees. Trees must be felled in the determined direction, without kickback or lodging, and felled trees must have limbs removed flush with the trunk. All safety precautions must be observed during felling and limbing operations.
2. Given access to felled trees with markings for bucking cuts, chain saw, and wedges, make bucking cuts in the felled trees. All cuts must be made on the markings, with all safety precautions observed.
3. Given a description of a plot of timber, plan the logging activities. Plan must include the following components and be rated acceptable according to the instructor-provided checklist: (a) rough sketch of the tract with roads and clearings marked, (b) market location, (c) types and numbers of workers needed, (d) equipment schedule, (e) plans for felling, limbing, and bucking, (f) description of and schedule for loading, hauling, and unloading operations, (g) estimated time schedule for logging activities, and (h) safety regulations and precautions to be observed.

Selected Enabling Objectives

1. Define terms associated with harvesting timber.
2. Identify how to make a tree fall in a predetermined direction.
3. Demonstrate how to make a tree fall in a predetermined direction.
4. State reasons for harvesting trees from noncommercial forest lands.
5. Describe the shortwood and longwood systems used in logging.
6. Identify factors which affect the cost of hauling logs.
7. Describe and identify advantages of total tree chipping.
8. Explain how to determine bucking cuts for crooked logs.

Criterion-Referenced Measures

1. Fell trees in a predetermined direction according to cutting patterns, with no kickback or lodging, and limb felled trees flush to the trunk, observing all safety precautions.
2. Make bucking cuts on the markings of felled trees, observing all safety precautions.
3. Plan logging activities for a given tract of forest land, to be rated acceptable according to instructor-provided checklist. Plan must include a rough sketch of the tract with roads and clearings marked; market location; types and numbers of workers needed; equipment schedule; outline of plans for felling, limbing, and bucking; description and schedule for loading, hauling, and unloading operations; estimated time schedule for logging and clean-up; and safety regulations and precautions to be observed.

Selected Instructional Activities

1. Have students define terms related to logging and hauling timber.
2. Arrange a field trip to a logging site so students can observe the equipment used in felling, limbing, and bucking operations.
3. Discuss and demonstrate how to determine the direction of fall for a felled tree. Have students outline felling procedure to make trees fall in various directions.
4. Discuss safety hazards connected with the felling of trees and how to avoid kickback and lodging; emphasize procedures for dealing with leaning, rotten, and lodged trees.
5. Discuss and compare the shortwood and longwood systems of harvesting.
6. Review information on intermediate cutting in Unit 6, and discuss both tree selection and reasons for harvesting trees in noncommercial forests.
7. Discuss the cost factors associated with hauling logs.
8. Arrange for students to observe chipping operation, and discuss the advantages of total tree chipping.
9. Demonstrate and have students practice felling, limbing, and bucking operations; demonstrate or discuss how to determine bucking cuts in crooked logs.

Selected Tools and Materials

Chain saw
Hammer
Wedges
Instructor-prepared vocabulary list
Instructor-provided checklist for evaluating harvesting plans
Slide projector, film projector, and screen

Selected Audiovisual Materials

Film: An American Sawmill. Audiovisual Department, University of Idaho.
Film: Mechanical Harvesting. Union Camp Corporation.
Film: The Paper Forest. Visual Aids Library, VPI.
Film: Waters of Coweeta. USDA, Forest Service.
Slides: The Pulpwood Producer. American Pulpwood Association.
Slides: Timberland Operations Mechanization in the Southeast. Forestry Department, VPI.

Selected References

Determining Fixed and Operating Costs of Logging Equipment. USDA, Forest Service.
Felling and Bucking Hardwoods--How to Improve Your Profit. Department of the Environment, Canadian Forestry Service.
Fundamentals of Logging. Allis-Chalmers.
Handbook of Eastern Timber Harvesting, pp. 23-35. USDA, Forest Service.
Health and Safety Code Handbook. USDA, Forest Service.
Pulpwood Production. W. S. Bromley.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. A commercial forest is managed to produce a timber crop. When the crop is mature, it should be harvested and a new crop allowed to grow. Logging the timber crop is as much a part of good forest management as planting, fire protection, or timber stand improvement. Logging is as important to the commercial forest as harvesting is to the farm.
2. Even in forests managed primarily for recreation, harvesting is needed. Intermediate cuttings keep the stand in top shape, open the stand to light, and establish undergrowth needed for wildlife production. Harvesting removes the trees at maturity, before they start the decline which makes them more susceptible to disease and insects.
3. Logging in a commercial forest, to be economical, must obtain the greatest return at the least cost. Many times this means the stand, or some portion of it, must be clear-cut. The scar left by a clear-cut operation is a temporary situation and in a commercial operation will soon be covered by a new forest.
4. Improper harvesting methods can turn a well managed, high-quality stand into low-grade timber.
5. Through proper harvesting and regeneration, the forest resource is perpetuated.

B. General situation

1. The planning of a logging operation should be done by a professional forester.
2. The plans for the harvest should be a part of the total management plan for the timber stand.
3. Harvesting is probably the most hazardous job in the total forest production cycle.

C. Local situation

1. Determine what harvesting operations are being conducted or planned in the local area. Identify these by the type of cutting practice, and determine the silvicultural benefits if it is an intermediate cutting.
2. Identify the end-use markets of the timber being cut, its approximate value per MBF delivered to the processing plant, and the component costs of the harvesting operation.
3. Determine who the local logging contractors are and the size and types of equipment and crews that they use in their operation.

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

A. Arrange field trips to forest areas to observe various stages of harvesting and the use of the equipment.
B. Arrange opportunities for students to use both portable and large mechanized equipment for harvesting operations.
C. Visit several stands of timber of various ages and types and have students recommend method of harvesting and give reasons.
D. List procedures or steps necessary to develop a harvesting plan; explain requirements for this section of long-term projects.

IV. EVALUATION

A. Student should fell one or more trees in accordance with CRM.
B. Student should limb and top one or more felled trees in accordance with CRM.
C. Plan of logging activities should include the following and be rated acceptable according to instructor-prepared checklist.

1. Rough sketch of tract with roads and clearings marked
2. Procedure for tree selection and product(s) to be sold
3. Market location
4. Types and numbers of workers and equipment needed
5. Plans for felling, limbing, and bucking
6. Schedule and plans for loading, hauling, and unloading
7. Estimated time schedule for logging activities and clean-up
8. Safety regulations and precautions to be observed

HARVESTING PLANS

II. PRESENTATION

A. Selecting trees to be cut

Review the material presented in Unit 6, paying special attention to the sections on intermediate cuttings and harvest cutting. It is important to note closely the selection of the trees to be cut or left in each cutting class. Identify and suggest examples of each cutting type being done in the local area.

B. Planning the operation

Planning a logging operation can be the most important part of the total harvesting procedure. Initial planning can reduce the total logging cost and increase the efficiency of the operation. A balance between the various operations in harvesting must be maintained and accurate information on production must be available in order to achieve this. The table below depicts a typical operation and shows how the various components have been balanced.

1. Operation control

It is important that a balance be maintained in all areas of operation. For example, adding more workers in the felling and bucking operation will not increase production unless similar increases are made in other operations such as bunching or skidding.

Logging system design table

Operation	Equipment[1]	Production per unit (MBF/day)	Number of units for a balanced system	Total production (MBF/day)
Felling and bucking	Power saw, 6 hp. class	6.7	3	20.1
Bunching & decking	58 DB, rubber-tired skidder	22.0	1	22.0
Skidding[2]	Same equipment used for B&D above (capacity approximately 0.60 MBF)	20.5	1	20.5
Loading	Hydraulic, tractor mounted (approximately 0.20 MBF capacity)	26.0	1	26.0
Hauling (50 mi.)	41,000 No. G. V. W., 190-hp. truck with trailer (approximately 4.0 MBF capacity)	8.1	3	24.3

[1] Abbreviations used are hp, horsepower; DB, drawbar; B&D, bunching and decking; MBF, thousand board feet; G.V.W., gross vehicle weight; No., pounds.

II. B. 2. **Logging systems**

Harvesting is composed of several integrated operations, each one having numerous possible approaches that can be used. The proper organization of the individual operations into the total harvesting operation represents the logging system. Basically, two logging operations can be considered: pulpwood harvesting and sawlog harvesting. The two operations might be conducted independently or simultaneously; additionally, both types of operations can be subdivided into two types of operations.

a. **Shortwood system**

The log is bucked into pulpwood or sawlog length at the stump and is moved from stump to mill in short lengths.

b. **Longwood system**

The log is hauled from the woods in tree length and is either bucked at the landing and hauled to the mill in short lengths, or it is loaded and hauled in long lengths and bucked at the mill.

C. **Felling trees**

Felling is the initial operation in the manufacturing of wood products. Today, felling is usually performed by one- or two-worker teams, using chain saws. Under normal conditions, a single worker is more efficient than a two-person team. With the development of hydraulic shear cutters and machinery designed for tree felling, the operation is becoming increasingly mechanized.

HYDRAULIC TREE SHEAR

II. C. 1. **Mechanized felling**

a. **Tractor-mounted tree shear**

A tree shear is a hydraulically operated blade which cuts against a fixed anvil. Shears can be mounted on skidding or bunching tractors or on a tractor used only for felling. Some shears will cut timber up to 24 inches in diameter.

b. **Harvesting machines**

Several manufacturers are currently marketing tree harvesting machines. Two general concepts of harvesting machines are being utilized.

(1) Feller-buncher--The feller-buncher has a felling head which clamps the tree at the base and at several points up the stem. A shear is incorporated on the felling head, and the tree can be lifted and placed in an overhead rack after the cut is made. The machine moves from tree to tree, adding each to its load until a full load is gathered. The load can then be moved to a landing or may be dropped for pickup by a skidder.

(2) Tree harvesters--The tree harvester incorporates additional equipment to limb, fell, buck and stack the cut-to-length wood. The machine will normally cut and stack a load or pallet of wood and drop it for movement to the landing by other machinery.

(3) Limitations--Normally the more complex the harvesting machine, the more dependent it is on terrain and conditions. A skidder-mounted shear can log most stands on which skidders can normally operate. On the other hand, a tree harvester is generally limited to flat or slightly sloped terrains, attaining its most efficient production in a plantation type of stand.

2. **Hand felling**

a. **Felling crew**

A feller equipped with a chain saw is responsible for felling and limbing the tree. In a shortwood system, the feller may also be responsible for bucking the tree to log or pulpwood length.

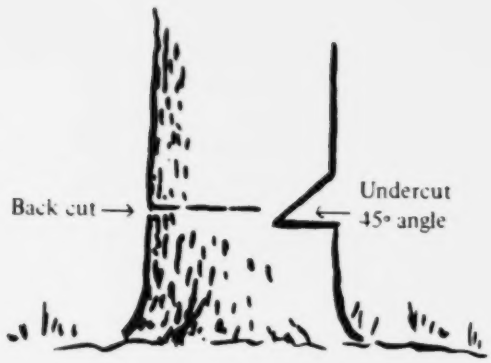
b. **Felling operation layout**

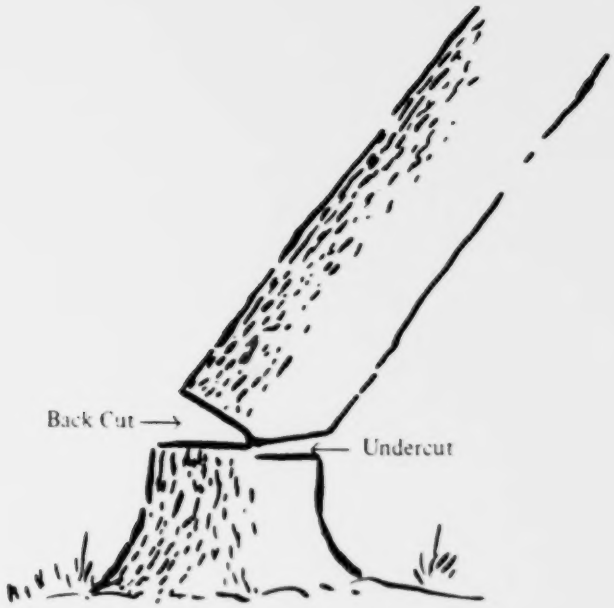
The general layout of the felling operation is very important and is the responsibility of the logging supervisor. Proper layout can save both time and work and is vitally important for the safety of the crew. Layout should be such that each crew member of the felling team works at a safe distance from all others. Trees should be felled in a manner that permits them to be easily reached by the skidders and still allow the fellers to progress through the stand.

c. **Direction of fall**

Before starting to saw, the feller should examine the tree to determine direction and location of the drop. A tree with well balanced limbs around the bole that leans no more than 5 degrees can usually be dropped in any direction. This is done by properly locating the undercut, wedging, and controlling the back cut. Normally, trees that lean more than 5 degrees or have unbalanced branching can be directed only 45 degrees to either side of the direction of the lean or center of weight.

II. C. 2. c. (Continued)





Normally a tree should not be felled straight up or straight down a steep slope. Under normal conditions, a tree felled straight up a slope may kick back over the stump and hit the feller, and trees felled straight down are subject to shattering in the fall. Trees should not be dropped across a rock, stump, or another log because the trunk may break.

d. **Work space clearance**

Brush and low-hanging branches should be cleared from the area around the base of the tree and a safe line of retreat should be made available.

e. **Tree cutting**

(1) **Undercut**

The undercut is made on the side of the tree, in the same direction that the tree is to fall. The undercut should provide a 45-degree notch with the bottom cut flat and the top cut angled, and it should extend to a depth of about one-quarter the diameter of the tree.

(2) **Backcut**

The backcut should be made two to four inches above the base of the undercut. The cut should continue into the tree until two or three inches of holding wood is left. If the tree has not begun to fall, it should then be wedged by driving one or two wedges behind the saw. Leaning trees can be directed by wedging on the leaning side of the backcut or by leaving a "holding corner." The holding corner is made in the backcut by leaving more wood on the side that is opposite the lean of the tree.

II. C. 2. e. (3) **Rotten trees**

Special care should be taken in felling trees with butt-rot. If possible, the cut should be made high enough to avoid the rot. If this is not possible, the backcut should be made by carefully sawing several cuts around the trunk.

(4) **Lodged trees**

A felled tree which lodges in a standing tree is potentially hazardous and care should be taken to prevent this from occuring. The safest and most practical method of dislodging a tree is by pulling it out with a skidder or wench. Never climb the trunk and try to shake it loose or attempt to cut the tree in which the first one is lodged.

D. **Limbing and bucking**

Limbing is usually done at the felling site by the felling crew. Bucking may be done by the felling crew, or the logs may be moved full length to be bucked at the landing or the mill.

1. **Bucking at the mill**

With the development of forest product complexes, the trend is toward tree-length logging with the bucking being done at the plant site. Bucking can then be done by large power-driven crosscut saws, and the bucking decision can be made by a trained worker. The cuts can be made to allow for maximum utilization of the log in any one of several plants. Peeler logs can be cut and sent to the plywood mill, sawlogs to the lumber mill, and tops and cull sections can be chipped for pulp.

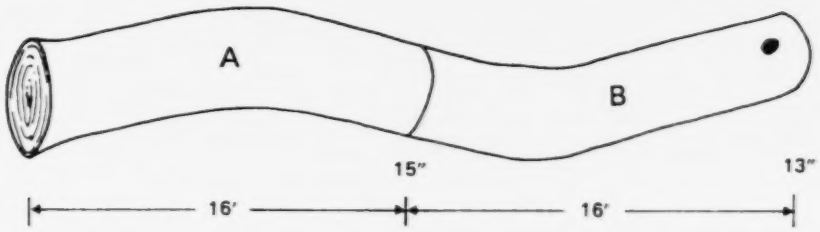
2. **Bucking at the landing**

In many instances it is more economical to move tree-length logs to the landing. The bucking can then be done by special machines or trained bucking crews. In tree-length logging, tops can be brought in with the sawlog, then segregated for pulp at the landing.

3. **Bucking at the stump**

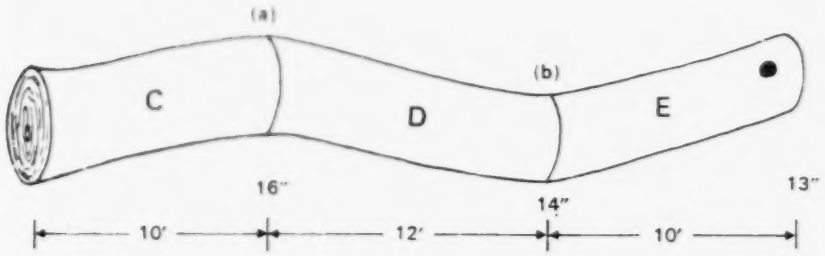
Bucking of pulpwood in the field is a matter of cutting the bole to the desired pulpwood length; cutting out undesirable defects, such as charred areas; and continuing up the bole to the minimum allowable top diameter. Bucking of sawlogs or veneer logs is a more critical task. Proper bucking can maximize the value of a tree and improper bucking can severely decrease the value.

II. D. 4. Bucking alternatives—crooked logs



NOT RECOMMENDED

Log	Log Grade	Dia. (in.)	Length (ft.)	Gross Scale (O.L.R.)	Net Scale (O.L.R.)	Log Value	Lbr. Value (per log)	Lbr. Value (per Mbf net scale)	Lbr. Value per Gross Cu. ft. of Log Volume
A	F-2	15	16	141	103	6.69	13.57	131.75	0.57
B	F-2	13	16	103	71	4.61	8.80	123.94	0.51
Total (and average) for tree					174	11.30	22.37	(128.56)	(0.54)



RECOMMENDED

Log	Log Grade	Dia. (in.)	Length (ft.)	Gross Scale (O.L.R.)	Net Scale (O.L.R.)	Log Value	Lbr. Value (per log)	Lbr. Value (per Mbf net scale)	Lbr. Value per Gross Cu. ft. of Log Volume
C	F-1	16	10	101	101	7.57	17.69	175.15	1.12
D	F-2	14	12	91	91	5.91	11.71	128.68	0.79
E	F-2	13	10	64	64	4.16	7.94	124.06	0.80
Total (and average) for tree					256	17.64	37.34	(145.86)	(0.92)

II. E. **Handling and skidding logs and bolts**

1. **Pulpwood--shortwood system**

a. **Truck loading at the stump**

This is the simplest method of handling pulpwood, and for a one- or two-person pulpwood harvesting crew, it may well be the cheapest way of producing pulpwood.

b. **Prehauling**

In a shortwood system using a larger crew, the pulpwood can be stacked on pallets by the felling-bucking crew and then picked up by a prehauler and moved to the landing. The prehauler may be a specially designed tractor built to carry one or more pallets or it may be a tractor pulling the pallets on skids.

c. **Tree-length skidding**

The logs are skidded to the landing by crawler tractors or rubber-tired skidders. If the logs are widely scattered, a bunching tractor may be used to move the logs together to allow the skidder to pick up a full load. If the logs are close together at the logging site, the bunching can be done with a power winch on the skidder.

Bunching and short skids can be made by dragging the logs behind a tractor. On long skids, the leading end of the logs should be raised off the ground. This is usually done with a logging arch which is high enough to lift the front end of the load from the ground. On most machines designed for skidding, the arch is an integral part of the machinery.

Securing the log is either done by using a wire rope looped over the log end, called a "choker," or by a hydraulic grapple mounted on the skidder, called "chokerless skidding."

2. **Sawlogs**

Sawlogs are usually skidded to a landing either in log lengths or tree lengths. The skidding practice is similar to that used in tree-length pulpwood skidding.

F. **Loading the timber**

The loading operation in most logging operations is mechanized. Occasionally on small pulpwood operations, loading may still be done by hand.

MECHANIZED LOADING EQUPMENT

II. F. 1. **Truck-mounted loaders**

In a one- or two-truck operation from a landing, or in most pulpwood operations loading at the stump, truck-mounted loaders are used. Since the truck driver serves as the loader operator, a worker and separate machine do not sit idle at the landing waiting for the truck to make a round trip to the mill.

2. **Loaders**

Operations involving several trucks are better suited to the use of one of the many available types of loaders. These fall into two general groups--front-end loaders mounted on tractors, and boom or crane loaders, either on truck bodies or as self-propelled units.

G. **Hauling the timber**

Several variables affect the cost of log hauling. To determine the proper size and number of trucks, the following should be considered.

1. **Material**

The truck should be designed to carry the material being hauled. Pulpwood bolts, logs, tree-length pulpwood, and tree-length sawtimber all may require different types of truck.

2. **Delay and standby**

Some delay and standby time while waiting for loading and unloading is unavoidable. Care in planning and scheduling of trucks to the landing and delivery point can minimize these delays. "Hot loading" (loading directly from the skidder to the truck) can cause delays. This can be avoided by maintaining enough logs at the landing to load all trucks as they arrive.

3. **Length of haul**

On short hauls, smaller trucks are more economical; on long hauls, larger trucks are better. This is because the loading and unloading time on short hauls represents a higher percentage of the total hauling time.

4. **Road standards**

A haul involving high mileage in woods and on secondary roads will be more expensive and require more trucks than a haul made essentially on paved roads.

H. **Chipping the total tree**

Total tree chipping requires a special piece of equipment designed to chip trees up to 22 inches in diameter. The trees are severed at the stump and then skidded to the chipper.

II. H. (Continued)

The chipper has grapples that pull the butt end of the tree into the mouth of the chipper. Rollers then feed the total tree into the body of the machine, where it is converted to chips. The chips are blown from the machine into a tractor-trailer van and transported directly to the pulp mill.

A total tree harvesting and chipping operation uses practically all the wood fiber on the site, thus making it more convenient and less costly to prepare the area for tree planting.

Unit 12 – Processing Timber Products

TASK ANALYSIS:

Performance Objectives

1. Given a written test on lumber processing, demonstrate understanding of the sawmill operation, including the function of each machine and worker and the basic layout of the mill, by completing the test with 80 percent accuracy.
2. Given necessary references and report guidelines, write a two- to three-page report on the part lumber processing plays in the total practice of forest management and in the economy of the local area. Report must be rated acceptable according to instructor-prepared checklist, based on the guidelines provided.

Enabling Objectives

1. Identify the types of sawmills and headrigs, and state the function of each.
2. Outline the operation of the carriage, the edger, and the trimmer.
3. Explain the basic layout of the typical sawmill.
4. Compare the processes of sawing for grade and sawing for maximum production.
5. Identify and describe the factors which influence quality control in the sawmill.
6. Identify the byproducts of sawmill operation and describe how they are used.
7. Describe the major wood-using industries and their place in the state's economy.

Criterion-Referenced Measures

1. Complete a written test on lumber processing and sawmill operation with 80 percent accuracy.
2. Write a two- to three-page report on the importance of lumber processing in forest management and in the economy of the local area, to be rated acceptable according to instructor-prepared checklist, based on guidelines provided.

Selected Instructional Activities

1. Discuss, outline, or diagram the basic sawmill operation, including the function of each piece of machinery and each worker.
2. Arrange a field trip to a sawmill and have students observe the equipment in operation.
3. Invite a local sawyer to discuss or demonstrate how logs are cut for grade and for maximum production; how machine balance is maintained in the sawmill; the quality control measures implemented at the mill; and how byproducts of the sawmill operation are used.
4. Arrange visits to local wood-using industries and have students identify their products, the raw materials required, and the work force drawn from the local area.

Selected Tools and Materials

Instructor-prepared test
Instructor-provided report guidelines
Instructor-provided checklist to evaluate reports
Slide projector, film projector, and screen

Selected Audiovisual Materials

Film: An American Sawmill. Audiovisual Department, University of Idaho.
Film: The Paper Forest. Visual Aids Library, VPI.
Slides: The Pulpwood Producer. American Pulpwood Association.
Slides: Sawmill Training Program. Southern Forest Products Association.
Slides: Timberland Operations Mechanization in the Southeast. Forestry Department, VPI.

Selected References

Circular Sawmills and Their Efficient Operation. Stanford J. Lunstrom.
Logging Farm Wood Crops. USDA, Farmer's Bulletin No. 1090.
Pulpwood Production. W. S. Bromley.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. Wood grows in a round form and is primarily used in a sheet or board form. Processing of timber products mainly involves the conversion of the round log into the rectangular sheet, board, or chips.
2. The properties of the final product depend on many variables, such as the species of wood, its rate of growth, the conversion method used in producing the product, the place in the tree from which it was obtained, and the treatments that it has received.
3. Virtually any piece of wood can be converted into a marketable wood product if the value of the product will cover the total cost of the conversion.

B. General situation

1. The wood-processing industry is one of Virginia's most important industries.
2. Markets for timber products in Virginia can be divided in the following four general classes, ranked according to total value of timber consumed:
   (1) Lumber, timbers, and other sawed wood products
   (2) Pulp, particle, and fiber products
   (3) Plywood and veneer
   (4) Posts, poles, and pilings
3. From the processing standpoint, lumber and sawed wood products are a locally important industry in most areas of the state. The other three classes are important to the state as a whole and are of prime importance in those areas in which plants are located.
4. The sawmilling industry is changing from an industry represented by small, portable mills to one of fewer and larger stationary mills.

C. Local situation

1. Determine the wood-processing plants in the local area. Identify their products, raw material requirement, and work force.
2. The content of this section should be adjusted to the local situation. If the local area has a pulp and paper mill, veneer and plywood plant, wood treating plant, or furniture plant, these topics should be included with assistance from local industry personnel.

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

A. Arrange for field trips to wood-processing plants so students can observe the processing or manufacturing of various products.

B. If possible, arrange for students to participate in supervised work projects at local wood processing plants or mills.

IV. EVALUATION

A. Test on lumber processing and sawmill operation (80 percent accuracy required)

B. Two- to three-page report on the importance of lumber processing in forest management and in the local economy (evaluated according to instructor-prepared checklist)

LUMBER PROCESSING

II. PRESENTATION

A. Lumber and sawed wood products

There are approximately 500 sawmills presently operating in the state of Virginia. These mills consume 46 percent of the timber volume cut and account for 60 percent of the value of timber cut.

1. Types of sawmills

Sawmills are generally classified by three factors.

a. **Species cut**
   (1) Hardwoods
   (2) Softwoods
   (3) Mixed

b. **Mobility of the sawmill**
   (1) A portable mill is one that is moved to a location near the timber supply.
   (2) A stationary mill is one located at a permanent site to which the logs are transported from the logging site.

c. **Type of headrig**
   (1) **Circular headrig**
   The primary breakdown saw is a circular saw, which is a disk with teeth on the outside perimeter. All portable mills and many stationary mills in Virginia use the circular headrig.
   (2) **Band headrig**
   The primary breakdown saw is a continuous band with teeth on one side. Because of its large size and the need for more permanent foundations, the band saw is used only in stationary mills.
   (3) **Chipping headrigs**
   Chipping headrigs are large, partially automated units that chip the outer portion of the log and saw the remainder into lumber and timber products. Chipping headrigs are continuous operations, with the log feeding into one end and the products coming out the other end. All mills utilizing chipping headrigs are stationary.
   (4) **Other headrigs**
   Although not used often in Virginia, several other types of headrigs are available for initial log breakdown, including gang mills, scragg mills, and multiple saw headrigs (both band and circular).

2. Basic sawmill equipment

Three types of machines are basically needed in any sawmill. Smaller mills may operate with only these three units, while larger mills will operate the three units along with additional equipment.

a. **Headrig**
The headrig is designed to convert the round log into rectangular units. The headrig may handle the complete breakdown or it may just be used for initial breakdown into units that can be further sawed on accessory equipment. The headrig is limited to making cuts in one plane of the log. The

II. A. 2. a. (Continued)

plane of cut can be changed by rotating the log prior to making a cut. Once the initial plane has been established by the first cut, all other cuts are either parallel or perpendicular to the initial plane.

(1) The headrig is a unit composed of machinery serving four basic parts.

(a) **The saw**

(b) **Log-holding mechanism**

The log must be restrained from turning or twisting as the cut is made. To ensure that boards will have parallel faces and squared edges, each cut must be accurately maintained as parallel or perpendicular to all other cuts.

(c) **Log-moving mechanism**

To make a cut, the log must be moved into and through the saw.

(d) **Lateral indexing mechanism**

In headrigs using a single saw (circular or band) one cut is made to obtain each board. The log is then moved laterally to a distance equivalent to the thickness of the desired board, and second cut is made.

(2) In most mills, the latter three functions are all performed by the log carriage.

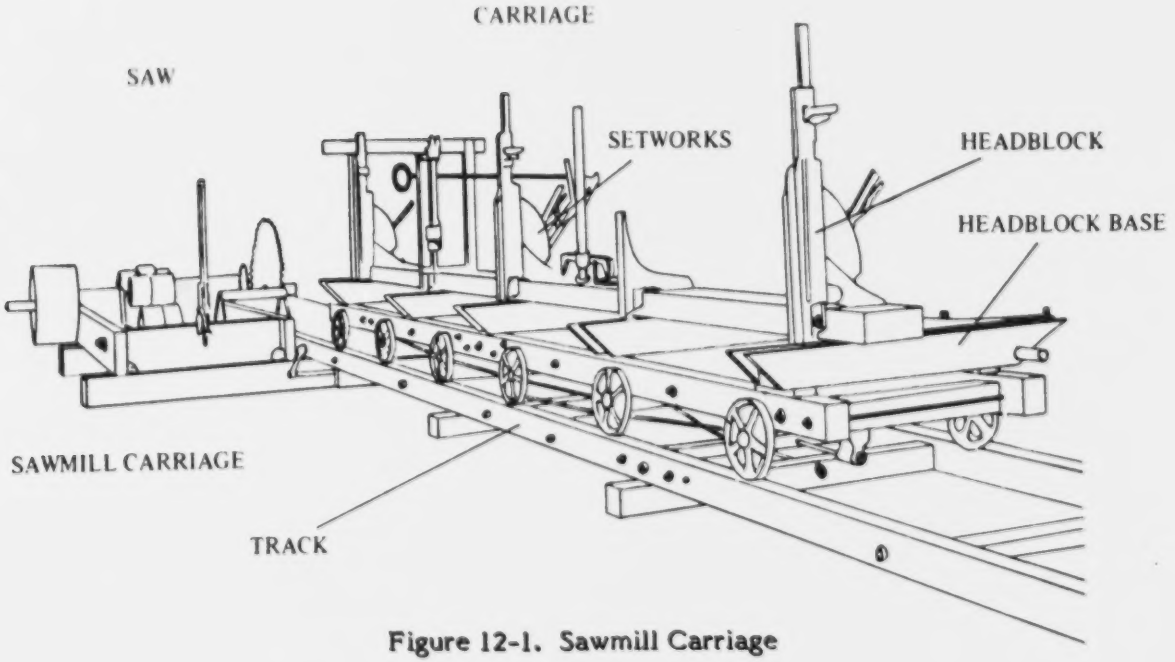


Figure 12-1. Sawmill Carriage

II. A. 2. a. (2) (Continued)

(a) **Carriage and log movement**

The carriage is mounted on tracks that run parallel to the saw. By moving the carriage along the tracks, the log is moved through the saw.

(b) **Superstructure of the carriage**

The carriage has a superstructure composed of a series of head blocks (knees) and head block bases (bolsters). The bolsters are mounted horizontally on the carriage, perpendicular to the saw. These form the base on which the log rests. The head blocks are at right angles to the base, and they provide additional support for the log and prevent it from moving away from the saw. To prevent the log from moving toward the saw and to prevent turning, pointed metal hooks (dogs) are mounted on the head block. These dogs extend out from the head block and are driven into the top of the log.

(c) **Setworks**

To index the log laterally, the head blocks are moved laterally along the head block bases. The mechanism for this is called the setworks. The setworks may be automated, and if this is the case, it is controlled by the head sawyer. On older or non-automated carriages, the setworks is operated manually through the use of ratchets and gears.

(3) The headrig is operated by one, two, three, or four individuals. Automation has made it possible for a single person (the head sawyer) to control the total headrig. Without automation, a "setter" rides the carriage to operate the setworks, along with one or two "doggers." (In small mills the setting can also be done manually by the sawyer.)

b. **Edger**

The boards cut from the periphery of the log contain edges that are neither square nor parallel. To produce lumber of standard width and squared edges, these boards are again sawed on the edger. The edger has two or more saws arranged on a common shaft, with one or more being movable along the shaft. The position of the saws determines the width of the boards, and the two saws provide parallel and square edges. The edger can also be used to cut narrower high-grade boards from wide, low-grade boards.

II. A. 2. c. **Trimmer**

As they come from the headsaw and edger, the ends of the boards and timbers may not be parallel or square, or the boards may not be standard length. They must then be trimmed. The trimmer may be a hand-operated swing saw or it may be a battery of saws mounted to cut the boards to length. The trimmer can also be used to upgrade lumber by segmenting the board into shorter lengths of higher grades.

d. **Basic mill layout**

The figure below shows a typical mill layout of a basic sawmill system.

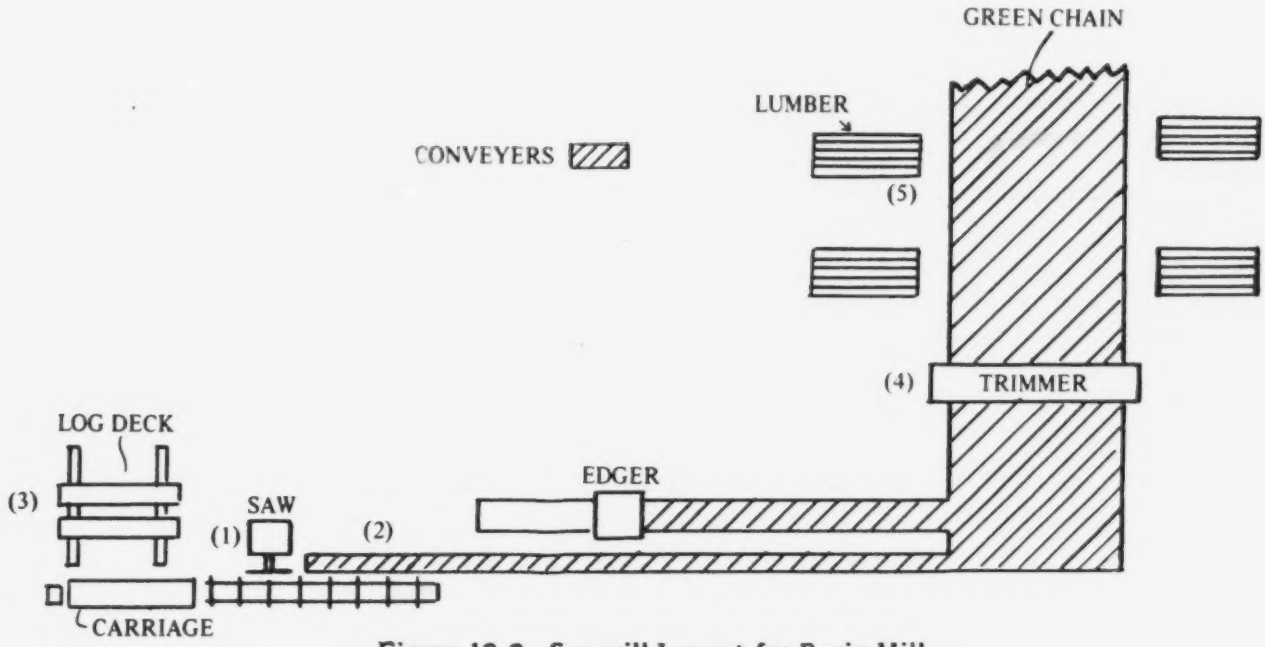


Figure 12-2. Sawmill Layout for Basic Mill

The numbers indicate the worker requirements: (1) sawyer, (2) edger, (3) decker, (4) trimmer, and (5) piler.

3. **Additional equipment**

The headsaw, edger, and trimmer are basic items needed in all sawmills. In many cases, small mills operate with only these three items. As the complexity of the mill increases, additional equipment is added. The individual types and designs of additional equipment are many and varied, but the general functions can be isolated and discussed.

a. **Debarker**

In the past, logs have normally been sawed with the bark on the log. However, in the past 25 years, a general trend toward debarking before sawing has occurred. Three factors have contributed to this increase in debarking.

II. A. 3. a. (Continued)

(1) The primary factor is that a market has developed for chipped waste wood for pulp. If edgings (the portion of the board removed from the lumber by the edger) are bark free, they can be chipped and sold to pulp mills.

(2) The life of the sawblade is an important consideration. It has been found that the saws can be used longer between sharpenings and replacement if the bark, with its dirt, gravel, and other foreign objects, is removed.

(3) Debarking allows the sawyer to see and identify defects so the log can more easily be positioned for maximum recovery.

b. **Log loader and turner**

A log can be loaded on the carriage and turned by hand, but efficiency is increased by the addition of mechanical loading and turning devices.

c. **Resaws**

In all mills, the headsaw generally controls the rate of production. To increase the mill production, a second headsaw may be installed; however, much greater efficiency usually can be obtained by the addition of resaws. The headsaw can break the log into multiples of boards and timbers, and a secondary breakdown or resaw can cut the individual components. To saw the log shown below on a headsaw would involve fourteen cuts and three turns (Figure 12-3A). Using resaws, the same log can be cut with two cuts and two turns on the headsaw (Figure 12-3B).

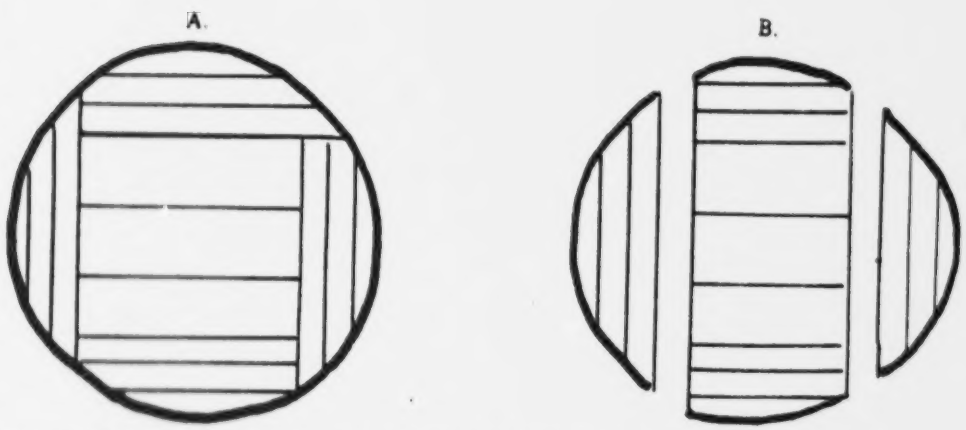


Figure 12-3. Cutting on Headsaw vs. Cutting into Cants and Resawing

II. A. 3. d. **Separators and stackers**

After the lumber has been cut, edged, and trimmed, it must be stacked for shipping or drying. Green lumber is usually sorted for size and species on the green chain, which is a conveyor belt or table from which the lumber can be pulled and stacked. Automated equipment is also available for selection according to size and for stacking lumber.

e. **Dryers**

Lumber should be dried according to the moisture content at which it will be used. Lumber from the log will contain anywhere from 35 to 50 percent by weight moisture, and must be dried to 7 to 10 percent for interior use, or 12 to 18 percent for exterior use.

(1) **Air drying**

Lumber stacked and exposed to the air will dry to about 15 percent moisture content over a period of several months.

(2) **Kiln drying**

To dry lumber to a moisture content of 7 to 10 percent or to accelerate the drying, large temperature and humidity control chambers called dry kilns ("kills") are used. Kiln drying of lumber is a specialized procedure; use of incorrect methods can severely degrade the lumber.

4. **Sawing procedure**

Two approaches may be used in sawing logs: sawing for maximum grade and sawing for maximum production. It has been commonly accepted that when sawing logs that contain high-grade lumber, the maximum value of lumber can be obtained by sawing to maximize the grade recovery. Low-grade logs that contain little or no high-grade lumber should be sawed to maximize production. Recent studies indicate, however, that sawing even high-grade logs for maximum production may provide the highest value return per log.

a. **Sawing for maximum production**

Grade sawing decreases production because the log must be turned to each face to saw the high-grade boards, where as "through and through" sawing (gang sawing) involves a minimal turning of the log. In gang sawing, the initial face is selected to maximize grade recovery. Boards are taken in the order of those nearest the log center; then the log is turned 180 degrees and boards are then taken from the opposite direction. Figure 12-4 illustrates this sawing method.

b. **Sawing for grade**

The high grade lumber occurs in the outer shell of the log. Grade sawing involves sawing around the log, taking the high grade lumber from the outer shell and leaving the center in timbers, dimension lumber, or sawing it "through and through" for low-grade boards.

II. A. 4. b. (Continued)

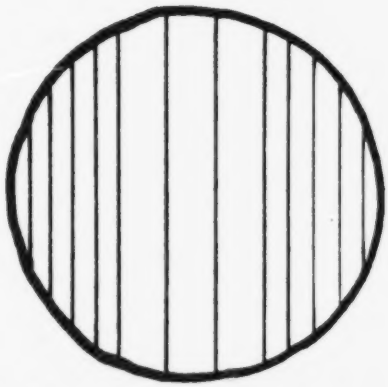


Figure 12-4. "Through and Through" or Gang Sawing

(1) **Log faces**

When sawing for grade, the sawyer must make initial sawing decisions based on the appearance of the log. By viewing the exterior and ends of the log, an idea of the defects that will appear in the boards can be obtained.

(a) Knots on the exterior will usually extend to the center of the log.

(b) Bumps on the exterior are indicative of a limb that has been removed or dropped off and has grown over. The sawyer knows that under the bump, a knot will be found. The size of the bump and the slopes of its sides will indicate the size of the knot and how far under the surface it is likely to appear.

(c) If a face is completely clear of knots or bumps, the sawyer will know that lumber sawed from this face will be of a high grade. If the log has all four faces clear, the log will produce high-grade lumber from all four cutting faces. Based on the number of clear faces and their relative position on the log, the sawyer decides how the log will be cut.

(2) **Taper sawing**

A special adaptation of grade sawing is the technique called "taper sawing." The bole of a tree does not grow as a true cylinder, but rather as a truncated cone with the diameter at the butt larger than at the top. This decrease in diameter up the bole is called "taper." The grain of the wood follows the exterior of the log and is not parallel to the center, and the grain on opposite sides of the log is not parallel. If the log is placed on the carriage with no consideration for taper, the first face cut will be cut in a plane parallel face that is against the head blocks. The resulting boards will not be parallel to the grain of the wood and the resulting lumber will contain gross grain. (See Figure 12-5A.)

II. A. 4. b. (Continued)

When the log is turned, the back side will automatically be sawed parallel to the face. Thus, if one face is a low-grade face and the opposite face is a high-grade, the high-grade face can be taper-sawed by placing it against the head blocks and initially cutting the opposite poor face (Figure 12-5B).

If both faces are high-grade, the head blocks of the small end of the log can be set forward so the outside face is parallel to the saw (Figure 12-5C). When the log is turned, the blocks must be adjusted again so that the original back face can be sawed parallel to the face of the log. Once the high-grade lumber has been taper-sawed and only low-grade material remains, the center cant is squared up by sawing off the wedges that are a result of the taper-sawing.

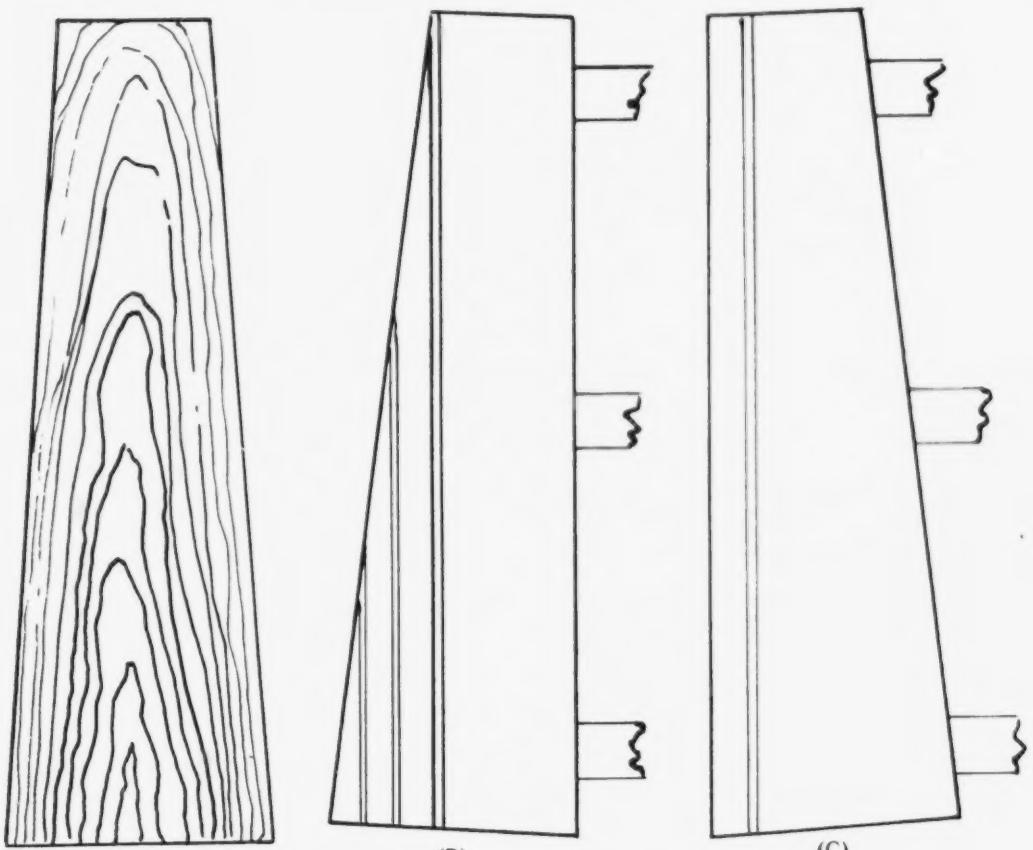


Figure 12-5. Taper and Taper-Sawing

II. A. 4. c. **Machinery balance**

In a simple sawmill operation with a headsaw, edger, and trimmer, little problem is encountered in machinery balance. The headsaw should set the production of the mill. If either the edger or trimmer control the production rate, the mill is out of balance and that unit should be replaced with one capable of keeping up with the headsaw.

In more complex mills, keeping machinery balanced can be a greater problem. The operator will have a choice of machines capable of performing a given cut. The flow of material must be adjusted to provide maximum utility of all machines, as well as maximum production from the mill.

In most mills, balancing is done by trial and error. The head sawyer determines how much breakdown should be done on the headsaw and decides where the remaining cutting should be done. Usually material is sent to a secondary breakdown machine to maintain all machines operating at full capacity, rather than to ensure maximum efficiency; unfortunately, full loading of all machines may not produce maximum mill efficiency.

A good mill manager or head sawyer may be able to improve efficiency through experience, but in order to assure maximum efficiency, the total mill balance for the various types of raw material and products should be determined. Advanced techniques are available to make these studies.

d. **Quality control**

The quality of the manufacture of lumber in the mill is as important as the quantity. In the sawing operation, two factors are important to the quality of the lumber produced.

(1) **Thickness**

Lumber sawed too thick will have a decrease in the recovery of material from the log. The excess thickness must be planed off to make the lumber usable.

Sawing lumber too thin will reduce its value, and before it can be used, it must be planed to the next thinner board size.

The lumber thickness control depends on the accuracy and dependability of the setworks. A well adjusted setwork should be able to cut to $\pm 1/16$ inch in lumber thickness.

(2) **Uniformity**

The thickness of a board may vary along its length. The size of the thinnest point will determine the usable thickness, because in order to utilize the board, it must be planed to a uniform thickness.

Thick and thin lumber can result from several causes:

(a) Poor alignment of tracks: If the carriage tracks are not parallel to the saw's cutting plane, the lumber will be thicker at one end than the other.

(b) Log not held properly: If the log slips or moves on the carriage while the cut is being made, or between cuts, the board will not be uniform in thickness.

II. A. 4. d. (2) (c) Misaligned headblocks: If the head blocks are not aligned accurately, uniform lumber cannot be cut.

(d) Head block base and knees not square with saw: If the head block is not perpendicular to the saw or the knees are not perpendicular to the base, the boards will be thicker on one side than the other.

A simple quality control program should be conducted in every mill. A random check on the thickness of lumber being produced by the mill should be made several times a day to provide the manager with necessary information to ensure proper manufacture of the lumber.

5. **Byproducts**

Although the production of lumber and sawed wood products is the primary objective of the sawmill, the economic state of the operation may be determined by the extent of byproduct use. In addition to lumber, the sawmill produces three other types of material--bark, wood waste, and sawdust. In the past few years, much has been done to develop uses for these materials. In 1980 approximately 92 percent of all plant byproducts were used.

a. **Bark**

Only recently has a market for bark developed and grown. The greatest portion of bark is used for horticultural and landscaping purposes as mulch, soil conditioner, and ground cover. Since 1973 increased volumes are being used as fuel in industrial furnaces. In 1980 about 91 percent of all bark was used.

b. **Wood waste**

In the sawing of the log, a portion of the solid wood is unusable for lumber. Most of this wood is the portion that must be cut from the round shape to produce the rectangles, slabs, and edgings. Any waste whole wood can be chipped and sold as pulp chips if a market is available. Some pulp mills will take only softwood chips, some will take mixed chips, but usually they must be separated into hardwood and softwood. Slabwood and edgings are also sold for residential firewood use.

c. **Sawdust**

Since 1973, sawdust has been used increasingly as a fuel in industrial furnaces, mainly in the large pulp and paper industry. Some is used in papermaking, particle board, mulch, and for animal litter. In 1980, about 82 percent of all sawdust produced was used.

B. **Pulp, particle and fiber products**

Pulp and paper mills and excelsior plants consume 32 percent of the round wood produced each year in Virginia, accounting for 14 percent of the timber value. In addition, pulp and paper mills, particle board plants, and fiber board plants consume a large quantity of chips and shavings from other wood products plants. There are seven pulp and paper mills in the state of Virginia. Two plants produce excelsior from round pine wood and seven plants convert chips or shavings into particle boards.

II. C. **Plywood and veneer**

The plywood and veneer industry accounts for 2 percent of the volume of timber consumed in Virginia, but the value consumed is 25 percent of the total timber value. Twenty-three plywood and veneer plants are located in the state, and all except one are hardwood plants.

D. **Posts, poles, and pilings**

Two percent of the state's timber harvest is consumed as posts, poles, and pilings.

All of the poles and pilings and some of the posts are processed at the state's wood preservative treatment plants. Additionally, they treat lumber, timber, and plywood. Virginia has 19 wood-treating plants.

E. **Remanufacturing plants**

Much of the sawed wood products produced by the sawmills are used as raw material for other industries in the state. Remanufacturing firms in the state include 50 furniture plants, 31 box or container plants, 4 flooring plants, 52 pallet plants, 32 planing mills, 36 millworks, and 21 homes and components manufacturers.

Unit 13 – Grading Lumber

TASK ANALYSIS:

Performance Objective

Given a written test on lumber grading, demonstrate knowledge of the rules for grading, the grades assigned to hardwood and softwood lumber, and terms used in lumber grading by completing the test with 80 percent accuracy.

Selected Enabling Objectives

1. Identify boards as hardwood or softwood.
2. List reasons for grading lumber.
3. Identify grades used for hardwood and softwood lumber.
4. Define terms used in lumber grading.
5. List steps to follow when evaluating lumber.
6. Identify career opportunities available for lumber graders.

Criterion-Referenced Measures

Complete a test on the rules of grading, the grades assigned to hardwood and softwood lumber, and the terms used in lumber grading with 80 percent accuracy.

Selected Instructional Activities

1. Display samples of hardwood and softwood boards and have students distinguish between the types.
2. Discuss reasons for and advantages in buying and selling graded lumber.
3. Have students contact various grading associations and request copies of the rules for grading lumber.
4. Prepare and distribute vocabulary sheets and have students define terms used in lumber grading.
5. Invite a lumber grader to explain and demonstrate grading procedures so students can observe both the process and the speed at which grading can be done.
6. Have students practice lumber grading, using prescribed procedures.
7. Discuss training requirements and job opportunities in the field of lumber grading. Have students save the information for use in the study of Unit 16, "Selecting a Career."

Selected Tools and Materials

Tape measure or grader's rule
Lumber for grading
Instructor-prepared vocabulary sheets
Instructor-prepared test on lumber grading

Selected Audiovisual Materials

None identified

Selected References

An Introduction of the Grading and Measurement of Hardwood Lumber. National Hardwood Lumber Association.

Rules for Measurement and Inspection of Hardwood and Cypress Lumber. National Hardwood Lumber Association.

Short Course in Grading. Southern Pine Inspection Bureau.

Standard Grading Rules for Southern Pine Lumber. Southern Pine Inspection Bureau.

Timber Products Grader Handbook. Timber Products Inspection Co., Inc.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. It is not the purpose of this unit of study to teach students the actual skills needed to grade lumber; however, it is important that students gain an understanding of the process in order to judge the quality of lumber and how it affects the economy of forest management.
2. Plan a tour of local sawmills, lumber concentration yards, or retail lumber yards so that students can observe and compare various grades of lumber, particularly the different hardwood and softwood grades.
3. Determine the number of qualified lumber graders in the local community and make students aware of the career opportunities in this field.

B. General situation

1. There are few qualified lumber graders in Virginia; there is a real demand for this skill.
2. Lumber industries sponsor courses in lumber grading to help meet this demand.

C. Local situation

Prior to beginning instruction on this unit, determine the number of qualified graders, the number of lumber businesses needing qualified graders, and the assistance available from local businesses to students interested in learning this skill.

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

A. Have a professional lumber grader pregrade several hardwood and softwood boards. Have students evaluate and grade the boards, giving reasons for the grade assigned.

B. Arrange a tour of various lumber businesses so students can observe the lumber-grading process.

C. Invite a lumber grader or local lumber business owner to explain job opportunities to students.

IV. EVALUATION

Written test on lumber grading (80 percent accuracy required)

LUMBER GRADING

II. PRESENTATION

A. Reasons for grading

1. **Measuring quality**

   a. Lumber grades are a means of measuring quality of lumber.
   b. Lumber grades provide both the buyer and seller with a "yardstick" for measuring quality and enable the purchasers to buy the grade or grades which best suit their needs.

2. **Establishing prices**

   Lumber grades serve as a basis for establishing prices.

3. **Establishing grades**

   The specifications for most jobs requiring lumber call for particular grades.

B. Advantages of grading to the industry

1. **Buyer**

   Grading provides a standard for ordering and guarantees suitable quality.

2. **Producer**

   Grading provides a standard for selling, changing the market from a local to a nationwide market.

3. **Middle vendor**

   Grading provides a method for operating without the necessity of seeing or taking possession of the lumber.

4. **Quality improvement**

   The manufacturing or mismanufacturing of lumber at the mill has a tremendous effect on lumber grades, and a few simple steps taken at the mill can improve lumber grades considerably. In hardwood lumber grading, for example, there are specific allowances for wane, splits, and pith; defects exceeding these specifications will cause the boards to be assigned less than a top grade. Proper edging and trim saw cutting can eliminate most of these defects and thus improve the grade.

C. Hardwood and softwood lumber grading

Hardwood lumber grades are entirely different from pine lumber grades. Pine is generally used in construction in the full width, thickness, and length that is cut at the sawmill. Because the grades are based primarily on strength, the size and distribution of knots are important. Pine is graded on the best side of the board.

Hardwood lumber is generally sold to a manufacturing plant that cuts the boards into much smaller pieces to make products such as furniture, boxes, and flooring. Hardwood lumber is graded primarily on the basis of the proportion of the board that can be cut into clear pieces, and the board is usually graded on its poorest side.

II. C. 1. Hardwood

a. Definitions

(1) Surface measure (SM)

This is the square foot surface of the board and is also called the board measure. To determine the SM of a board for grading purposes, multiply width (in inches) by length (in feet) and divide by 12; round off to the nearest whole number. For example, the SM of a 5-inch by 14-foot board = 5 x 14 ÷ 12 = 5-5/6, rounded off to 6 feet SM.

(2) Cutting

This is the part of a board that can be obtained by cross cutting, ripping, or both. The part (or cutting) cannot be less than the minimum dimensions specified for each grade.

(a) Clear face cutting

This is a cutting having one clear face and the reverse side sound, as defined below. The clear face of the cutting is on the poor side of the board except when otherwise specified. Admissible defects are ordinary season checks; unlimited sapwood; mineral streaks and spots; burls; and stain, provided it will dress out. Cuttings must be smaller than certain minimum sizes designated for each grade of lumber. For example, for FAS, the minimum size is 4 inches by 5 feet or 3 inches by 7 feet. For No. 2C, cuttings may be as small as 3 inches by 2 feet.

(b) Sound cutting

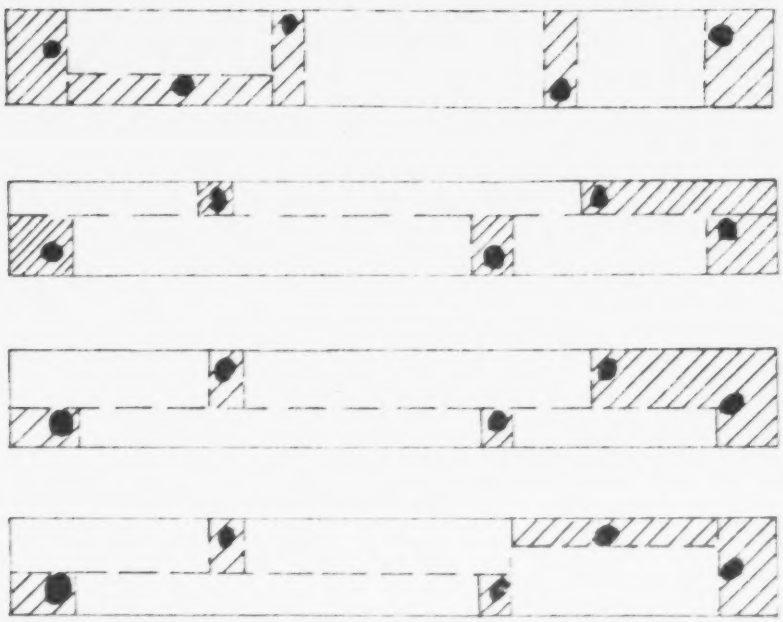
A cutting free from rot, pith, shake, and wane is considered sound. It will admit sound knots, sound bird pecks, stain, streaks or their equivalent, season checks not materially impairing the strength of the cutting, pin, shot, and spot worm holes. Other holes 1/2 inch or larger are admitted but shall be limited as follows: two 1/4 inch or one 1/2 inch in diameter to each 12 units (144 square inches) and only one side of a cutting. Texture is not considered in sound cutting.

b. Mechanics of grading

With some exceptions, hardwood lumber is graded on the basis of the size and number of cuttings (pieces) which can be obtained from a board when it is cut up and used in the manufacture of a hardwood product such as furniture, flooring, or interior house trim. The best grade has the largest area of usable material; when cut up for remanufacture, nearly all of the best grade can be used in a small number of large-sized cuttings. Lower grade boards will produce several smaller-sized cuttings.

The following drawings are examples of how hardwood boards might be cut to get clear cuttings. The black circles represent the knots and the shaded portion represents the lumber that would be thrown away as waste; the dashed lines represent the saw cuts.

II. C. 1. b. (Continued)



c. **Standard grades**

Hardwood lumber is classified as follows:

(1) First
(2) Seconds
(3) Select
(4) No. 1 Common
(5) No. 2 Common, Sound Wormy
(6) No. 3A Common
(7) No. 3B Common

d. **Grade combinations**

Lumber may be sold separately by each grade or in the following combinations of grades.

(1) FAS--first and seconds usually combined as one grade.
(2) Selects--generally speaking, FAS on the good face and No. 1 Common or better on the poor face.
(3) No. 1 Common and Better--the full run of the logs with grades below No. 1 Common excluded.
(4) No. 1 Common and Better (Log Run)--the full run of the logs, excluding all grades below No. 1 Common as defined for the various species under "standard inspection."
(5) No. 3B Common and Better (Mill Run)--the full run of the logs; below grade lumber excluded.
(6) No. 3A Common and 3B Common--may be combined as No. 3 Common.

II. C. 1. d. (Continued)

Simplified Hardwood Standard Lumber Grades

	FAS	SELECTS	1 COMMON	2 COMMON	3A	3B
WIDTH	6" +	4" +	3" +	3" +	3" +	3" +
LENGTHS	8'-16'	6'-16'	4'-16'	4'-16'	4'-16'	4'-16'
No. of cuttings allowed	$\frac{SM}{4}$	$\frac{SM}{4}$	$\frac{SM + 1}{3}$ (not over 5)	$\frac{SM}{2}$ (not over 7)	No limit	No limit
Minimum size of cuttings	4" x 5' or 3" x 7'	4" x 5' or 3" x 7'	4" x 2' or 3" x 3'	3" x 2'	3" x 2'	1½" x 2'
Amount required CF cuttings	10/12	10/12 FAS good side – 1 Com or better on poor side	8/12	6/12	4/12	3/12 (sound cuttings)
PITH	Length in inches no greater than SM	Same as FAS	½ the length	No limit	No limit	No limit

e. **Grading procedure**

(1) Determine species.
(2) Determine SM, using lumber scale stick.
(3) Determine poor side of board. (The hardwood grade is determined from the poor side of the board, except when otherwise specified.)
(4) Assume grade of board.
(5) Determine number of cuttings permitted in assumed grade.
(6) Determine clear-face cutting units needed.
(7) Determine area of permitted clear-face cuttings in units.
(8) If board does not yield sufficient clear-face cuttings units of the right size and number of cuttings, try next lower grade.
(9) Tally SM by grade and thickness on basis of 1-inch lumber, as follows: Random width lumber of standard grades and thicknesses is the tallied surface measure and this tally is the number of feet, SM, of 1-inch lumber. In lumber thicker than 1 inch, the tally so obtained is multiplied by the thickness as expressed in inches and fractions of an inch. For example, for 5/4 lumber, add 1/4; for 6/4 lumber, add 1/2; for 8/4 lumber, multiply by 2. Lumber less than 1 inch thick shall be measured and tallied as 1 inch lumber.

II. C. 2. **Softwood**

a. **Definitions**

(1) **Check**--A lengthwise separation of the wood, most of which occurs across the rings of annual growth.

(2) **Decay**--A disintegration of the wood substance due to the action of wood-destroying fungi. It is also known as "dote" and "rot." Firm red heart is a stage of incipient decay characterized by a reddish color produced in the heartwood, which does not render the wood unfit for the majority of yard purposes.

(3) **Holes**--May extend partially or entirely through a piece due to any cause. When holes are permitted, the average of maximum and minimum diameters measured at right angles to the direction of the hole shall be used in measuring the size, unless otherwise stated.

(4) **Knots**--A segment of a branch or limb embedded in the tree which has been cut through in the process of lumber manufacture. Knots are classified according to size, form, quality, and occurrence.

(5) **Mismanufacture**--Includes all imperfections or blemishes which are produced in manufacturing.

(6) **Pitch**--An accumulation of resin in the wood cells that is found in a more-or-less irregular patch.

(7) **Pith**--The small soft core occurring in the structural center of a log. The wood immediately surrounding the pith often contains small checks, shakes, or numerous pin knots, and is discolored; any such combination is known as heart center.

(8) **Shake**--A lengthwise separation along the grain, most of which occurs between the rings of annual growth.

(9) **Split**--A lengthwise separation of the wood extending through the piece from one surface to the opposite, or adjoining, surface.

(10) **Stain**--A discoloration occurring on or in lumber, of any color other than the natural color of the piece.

(11) **Wane**--Bark, or the lack of wood due to any cause, on the surface of lumber.

(12) **Warp**--Any variation from a true or plane surface. It includes bow, crook, cup, or any combination thereof.

b. **Grading mechanics**

Softwood is usually used as a whole piece and graded from the better face according to the defect method. To a great extent, grade is based on strength. The main consumption of softwood lumber is in construction.

c. **Grading classifications of softwood lumber**

(1) Yard lumber--Ordinarily used for general construction; carried in stock by the retailer.

(2) Structural lumber, timbers, dimension--Lumber 2 inches or more in thickness, to which definite work stresses are assigned.

(3) Factory, shop--Usually used for remanufacturing purposes.

II. C. 2. d. **Lumber grades**

(1) **Select**

(a) **A Finish**--One face practically clear, in a width 12 inches or less.

(b) **B Finish**--Will admit small surface checks, slight cup, one short split in end, several small knots, or a small percentage of stain.

(c) **C Finish**--Will admit the following or equivalent: medium surface checks, slight cup, medium split, an average of six pin holes per surface foot, small knots, light pitch, 25 percent firm red heart, and other minor defects.

(2) **Common**

Standard widths for all common grades are 2 inches and wider; standard lengths are 4 to 20 feet.

(a) **No. 1 Common** --Pattern must be suitable for use without waste, and will admit the following or the equivalent: sound, firm knots; medium cup; checks; a limited number of pin holes well scattered; pitch pockets; pith; medium shake; medium splits; firm red heart; light stain

(b) **No. 2 Common** --Will admit the following, or equivalent: knots not necessarily sound, deep cut, medium holes, deep torn grain or other imperfections in dressing that will not cause waste, pitch pockets, firm red heart, streaks of advanced decay

(c) **No. 3 Common** --Must be suitable for use as a whole for low-cost sheathing and will admit the following, or equivalent: large knots, loose knots, decayed knots, splits, through checks, through shakes, mismanufacture, pitch pockets, pitch, red heart, stain, wane

(d) **No. 4 Common** --Will admit all pieces that fall below the grade of No. 3, excluding such pieces that will not hold in place by nailing after wasting one-quarter of the length of the piece by cutting into two or three pieces

D. **Career opportunities available to lumber graders**

1. **Considerations**

a. There is a shortage of qualified lumber graders.
b. Lumber grading is a respected job that pays well.
c. Jobs are not confined to any one area.
d. Modern working conditions are provided through modernization and mechanization of equipment and facilities.

2. **Advancement**

The knowledge of grading is the basic requirement for advancement to supervisory, purchasing, sales management, and ownership positions.

II. D. 3. **Training requirements**

a. A high school education is preferred. A grader must be in good physical condition and have an aptitude for figures and an ability to work with people.

b. Special training schools are available.

(1) **Hardwood grading**
Hardwood Inspection School
Memphis, Tennessee

(2) **Softwood grading (on-the-job training)**

(a) Southern Pine Inspection Bureau
New Orleans, Louisana

(b) Timber Products Inspection Co.
Conyers, Georgia

Unit 14 Growing Christmas Trees

TASK ANALYSIS:

Performance Objective

Given written guidelines on plan report and access to or description of a suitable site, develop a written plan for producing and marketing Christmas trees on that site. Plan must answer the following questions and be judged acceptable according to guidelines provided.

1. Why is this site suitable for growing Christmas trees?
2. What varieties of trees should be planted?
3. How many trees should be planted?
4. What planting method(s) will be used?
5. How should the trees be maintained?
6. What possible problems may be encountered?
7. How will the trees be harvested?
8. How will the trees be marketed?
9. What records must be kept?

Selected Enabling Objectives

1. Determine characteristics of a suitable site for growing Christmas trees.
2. Determine suitable tree varieties.
3. Identify sources of adequate, healthy tree stock.
4. Outline procedure for hand or machine planting.
5. Determine schedule for pruning and shaping (shearing) operations.
6. Demonstrate procedure for shaping trees.
7. Identify insects, diseases, and animals that may damage trees.
8. Outline procedures for harvesting, grading, and tying trees.
9. Identify marketing methods.
10. Identify records which must be kept to determine profit or loss from Christmas tree production.
11. Define terms associated with Christmas tree production.

Criterion-Referenced Measure

Develop a written plan for producing and marketing Christmas trees on a selected site. Plan must be complete as described in the performance objective and must be written according to instructor-prepared guidelines.

Selected Instructional Activities

1. Arrange visits to several sites and discuss their suitability for Christmas tree production.
2. Invite a forester to visit the classroom and discuss the varieties of Christmas trees, characteristics of good planting stock, and procedures for planting.

3. Demonstrate and have students practice shaping Christmas trees.
4. Discuss optimum growing conditions for various trees and how to protect the trees from various hazards.
5. Discuss the advantages and disadvantages of various harvesting schedules.
6. Invite a Christmas tree grower to explain how trees are marketed and to discuss the records that must be kept for this business.

Selected Tools and Materials

Tree planting tools (shovel, mattock, planting bar)
Tree pruning tools (pruning saw, hand shears, electric shears, and shearing knife)
Sample trees for tree-shaping instruction
Instructor-prepared guidelines on plan report
List of commercial and government nurseries selling Christmas tree planting stock (available from Virginia Division of Forestry or VPI Extension Forester)

Selected Audiovisual Materials

None identified

Selected References

Christmas Trees--The Tradition and the Trade. USDA Agriculture Information Bulletin No. 94.
Growing Christmas Trees in the South. USDA, Forest Service General Report SA-GR5.
Growing Christmas Trees in Virginia. VPI Extension Service, Bulletin 507.
Technical Manual for Christmas Tree Farmers. Allied Chemical Corporation.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. Growing Christmas trees is a year-round job.
2. Before entering the business, the grower must identify the local and distant markets.
3. Careful attention must be given to the area selected, tree species to be raised, and labor available for tending the trees.
4. Christmas tree growing can be a profitable enterprise.

B. General situation

Many people think that all one has to do to make a lot of money raising Christmas trees is to plant any species of evergreen tree on any available area of land and wait.

C. Local situation

Obtain answers to the following from the students:

1. Who has Christmas tree plantations?
2. Who has helped "tend" Christmas tree plantations?
3. Who has marketed Christmas trees?
4. What species and how many of each species are sold locally?
5. Where do the locally marketed trees come from?

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

A. Arrange a field trip to an operational Christmas tree plantation for purposes of observation and information-gathering for the students' plans for producing and marketing Christmas trees.

B. Arrange Christmas tree shaping demonstration and student practice session.

IV. EVALUATION

Evaluate written plan for producing and marketing Christmas trees according to guidelines and completeness of answers to the questions listed in the performance objective.

II. PRESENTATION

During the past 25 years, considerable interest has developed in Christmas tree production in Virginia. Prior to and even during this period, many of the trees used locally at Christmas were shipped in from other States and from Canada, but recently, more and more of our trees are produced at Virginia plantations. It is possible that in the near future, very few of our trees will come from outside sources.

The Christmas tree market is due to become very competitive. Growers must produce quality trees, and to do this, effective management practices must be implemented. Christmas tree production requires an eight- to ten-year investment before any income is realized. More than $1.00 per tree is usually spent on materials alone before a Christmas tree matures.

A. Site selection

1. Accessibility

A successful site must be near an all-weather road. To discourage theft of the trees, the site should be near a dwelling. The grower who intends to establish a choose-and-cut operation will find it almost always necessary to live on the site. A large, all-weather parking area for customers is desirable.

2. Topography

Level to gently rolling land is best; cultural operations are much easier on this type of land.

3. Present land use

A clean, medium fertile piece of gently rolling pasture land is desirable. Cutover or newly cleared land should be avoided. Very rich upland or bottomland will require expensive vegetation control.

4. Soil

Soil should be neither too poor nor too fertile. Poor soils produce poorly formed, off-color trees. Very fertile soils cause the trees to grow too fast. Soil should be easily worked, have good depth, be well drained, and not be too rocky.

B. Site preparation

1. Land must be cleared of all trees and brush and should be mowed clean.
2. Surface rocks should be removed.
3. Both large and small border trees should be cut; otherwise seedlings will be shaded.
4. Roads, loading areas, and parking areas must be set aside.
5. Rows must be determined.
   a. Seedlings should be planted on the contour if the land slopes steeply.
   b. If rows are to be mowed both ways, seedlings must be planted in a checkerboard pattern and turning space for the mower must be cleared.

II. C. **Species selection**

1. The species selected depends upon the climate, the soil conditions, and the market demand.
2. The tree species which do best in Virginia and most preferred by consumers are white pine, scotch pine, Norway spruce, and Fraser fir. Species should not be mixed in a row.

A GUIDE TO REGION AND SPECIES

Coastal Plain	Piedmont	Mountain
White pine	White pine	White pine
Scotch pine	Scotch pine	Scotch pine
Virginia pine	Virginia pine	Virginia pine
	Norway spruce	Norway spruce
		Fraser fir

D. **Planting stock selection**

1. **Age**

It is best to plant two-year-old seedlings, except for Virginia pine from southern nurseries, which is planted from one-year-old seedlings.

2. **Source**

Christmas tree seedlings can be obtained from either state or private nurseries. Private nurseries are usually two to three times more expensive than state nurseries. Good stock is essential to growing success.

E. **Planting procedure**

1. **When to plant**

Spring planting is recommended, usually from late February through April, depending upon the locality and seasonal weather.

2. **How to handle the seedlings**

a. Ideally, seedlings should be planted as soon as they arrive from the nursery. State nursery seedlings will last two to three weeks.
b. If a delay is necessary, seedlings should be stored in a cool, shaded place with ample air circulation around the bundles.
c. During planting, seedlings should be carried in a bucket or planting bag. If seedlings are moss-packed, wet moss and water should be added to the bucket. If seedlings are clay-packed, they should be covered with moist burlap bags, with no water added.

3. **Planting techniques**

a. Most seedlings that are planted by hand are dibbled into the soil with a planting bar. If machine planting is desired, the machine may be rented from the local forester.

II. E. 3. b. Planting techniques are outlined in Unit 7, "Reproducing the Forest."

c. Spacing may be determined according to the following guidelines.

(1) If the site is to be mowed with a farm tractor, the rows should be 10 feet wide, and seedlings in each row should be 5 feet apart.

(2) If the site is to be mowed with a small riding lawnmower, the rows should be 6 feet wide, with seedlings 6 feet apart.

(3) If the site is to be mowed with a walk-behind mower, the rows should be 5 feet wide, with seedlings 5 feet apart.

F. **Rotation**

1. A one-time planting will be ready for harvesting in 8 to 12 years; seedlings are not replanted.
2. To obtain an income each year, a definite number of seedlings are planted each year. Trees are harvested when they are 5 to 10 feet tall.
3. A given area may be planted over 3 or 4 years, and trees are chosen and cut and seedlings replanted within the same area each year. This method is good for the small grower.

G. **Maintenance and protection**

1. **Control of vegetation**

Two or three mowings a year are sufficient. Chemicals to control grass and hardwood brush should be used with caution, as weeds invade where grasses are controlled.

2. **Fire**

Protection from fire is essential. Grass, weeds, and brush should be mowed to reduce danger of fire. Good relationships with neighbors help reduce this hazard.

3. **Livestock and rodents**

Livestock can be fenced out; rodents can be controlled by mowing or by use of poison bait.

4. **Insects**

a. White pine weevils attack white pine.
b. Bagworms and red spiders attack Norway spruce and Fraser fir.
c. Tip moths attack all pines except white pine.
d. Saw flies attack all pines.
e. Aphids attack all pines, but are especially damaging to white pine.
f. Bees, wasps, and hornets do not damage trees, but are pests to the grower.

II. G. 5. **Diseases**

a. Needle cast is a disease of scotch pine.
b. Die-back and root decline are diseases of the white pine and Fraser fir.

H. **Cultural operations**

Shearing is essential to the growth of quality trees.

1. **Purpose**

Shearing is done to shape trees and to produce thick, dense foliage. Sometimes it is done to salvage a damaged tree.

2. **When to shear**

a. Shearing should be done when the top leader of the tree grows more than 12 inches in length, usually the third year. Pines are sheared in spring and early summer (June 1 to July 15), before new growth hardens. Spruce and fir may be sheared any time, but the winter months are preferable.
b. Once shearing is started, the tree must be sheared from top to bottom every year. Shearing should be done as lightly as possible the last year before the tree is sold.

3. **How to shear**

Start with the terminal at 12 inches or less, and make the cut on a 45-degree angle so that one new bud will form in a dominant position; then shear the lateral branches to shape the tree into an inverted cone. Shearing skill comes with practice and observation. Instructions are included in VPI Extension Service Bulletin 507.

4. **Tools for shearing**

Tools include hedge shears, electric shears, and shearing knife. A small hand pruner may be used for the terminal shoot and to establish the handle. If a handle is desired, it should be established either before the age of five or at the time of cutting.

I. **Marketing methods**

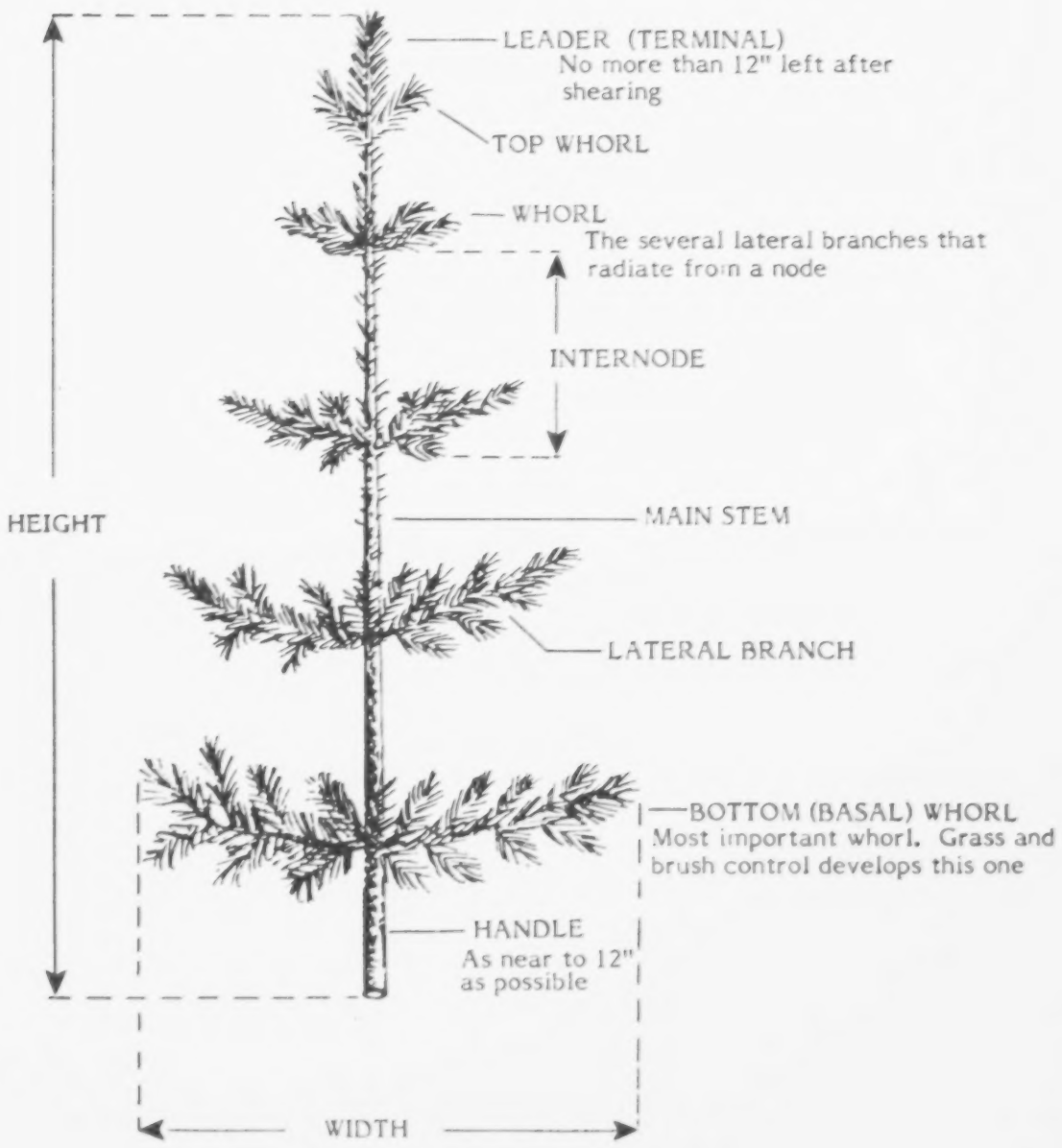
1. **Wholesale**

a. Marked or flagged individual trees may be sold, or the entire crop may be sold on the stump for a fixed amount per tree. The entire stand of trees is seldom ready for harvest at one time; it usually takes three to four years to liquidate a stand.
b. Trees may be cut and prepared for pickup at the site. Most trees sold this way are fixed with a stump and netting.
c. Trees may be cut, readied, and delivered to the marketplace.

2. **Retail**

a. Customers come to the plantation to select and cut trees. Usually, saws, car top or trunk ropes, and netting for the trees are provided.
b. The grower may set up a retail lot in town for a self-employed operation. Trees are sold in upright tree holders.

SOME TERMS USED IN GROWING CHRISTMAS TREES



Unit 15– Protecting the Forest

TASK ANALYSIS:

Performance Objective

Given preparation guidelines and access to a tract of forest land, prepare a written plan to protect the land from uncontrolled fire, insects, disease, and livestock. Plan must include possible causes of fire; how fire would be detected and plotted; possible fire control methods; identification of specific insects and diseases which could attack the particular tree species; and how these trees could be protected from insect attack, disease, rodents, and livestock. Plan must be rated acceptable according to instructor-prepared checklist based on guidelines provided.

Selected Enabling Objectives

1. Describe the economic damage occurring in the state annually from forest fires, insects, and disease.
2. State four rules and three laws designed to prevent forest fires.
3. Describe two methods of forest fire detection.
4. Identify facts which must be known in order to fight a forest fire effectively.
5. Explain the direct and indirect attack methods of fire control.
6. Describe how mechanized equipment and aircraft are used to fight forest fires.
7. Identify five harmful insects and their effects on the forest.
8. Describe three tree diseases and their symptoms.
9. Explain how livestock and mice damage the forest and how to eliminate these dangers.

Criterion-Referenced Measure

Prepare a written plan to protect a selected forest tract from fire, insects, disease, and livestock. Plan must include those elements listed in the performance objective and be rated acceptable according to instructor's checklist, based on guidelines provided.

Selected Instructional Activities

1. Display graphs and charts citing forest fire statistics. Have selected students investigate the causes of such widespread damage from fires in 1952 and 1963.
2. Discuss the impact of forest fores, insects, and disease on the state and local economy. If there are woods in the local area recently damaged by fire or widespread disease, have students visit the site. Ask them to estimate the different sources of income lost through the damage.

3. Arrange a field trip to a forest fire lookout tower and ask the observer to demonstrate the use of instruments used to plot fire locations.
4. Have students create a bulletin board display on fire prevention rules and laws.
5. Display and explain the use of common farm tools in fire control.
6. Display pictures of insects harmful to trees. Have selected students contact a local forester and obtain information on control of these insects.
7. Distribute the color brochure on forest tree diseases (available from VPI Extension Division or Virginia Division of Forestry). Emphasize the importance of being able to recognize tree diseases in their early stages.

Selected Tools and Materials

Farm tools used in firefighting
Film projector, filmstrip projector, and screen
Instructor-prepared guidelines and checklist for evaluating protection plan

Selected Audiovisual Materials

Filmstrip: Protecting the Forests. Filmstrip No. 9, Virginia Forest Series (#01750). Audiovisual Services, Virginia Department of Education.

Selected References

Eastern Forest Insects. USDA, Forestry Service.
Forestry in the South. M. D. Mobley and R. N. Hoskins.
Insects and Diseases of Trees in the South. USDA, Forest Service.
Forest Tree Diseases of Virginia. Virginia Division of Forestry. (booklet)

LESSON PLAN:

I. PREPARATION

A. Lesson approach

1. The importance of forest protection
2. The forest in terms of economic, watershed, wildlife, recreational, and aesthetic values

B. General situation

1. Many fires destroy the forests each year in Virginia and in other parts of the United States. Forest fires can be prevented.
2. A knowledge of the insects and diseases that damage forests is helpful in controlling serious outbreaks and resultant loss of timber.
3. Animals may seriously damage a forest; such damage can usually be prevented if proper measures are used.

C. Local situation

1. Information to be collected prior to unit study
   a. Number of fires that have damaged local forests during the past year
   b. Number of acres of local forest burned during the past year
   c. Value of forest products destroyed by fire in the local area during the past year
2. Information to be collected fro n students
   a. Description of any fire, insect, or disease damage done to family farm or forest land
   b. Protective measures undertaken by students or their families

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

A. Construct a fire lane on a farm as a class project.
B. Visit a forest fire lookout tower and have students learn how to plot the location of a fire observed from the tower. Have them learn the procedure for reporting a forest fire.
C. Have students collect specimens of insects that attack local forests.
D. Have students collect and label a specimen of wood damaged by each insect or disease common to the community.
E. Have students observe and report on protective practices undertaken on a local farm to prevent animals from damaging the forest land.

IV. EVALUATION

Have students construct a forest protection plan as described in the performance objective, based on guidelines. Evaluate according to checklist.

FOREST PROTECTION

II. PRESENTATION

In the previous units, the important role Virginia's forests play in our economy has been identified, as well as methods to establish and manage forests. For timberlands to be of the greatest value to the most people, they must be protected.

A. Forest fires

1. Virginia's forest fire record

The number of forest fires from 1945-1982 is shown in Chart A. The number of acres burned in these same years in shown in Chart B.

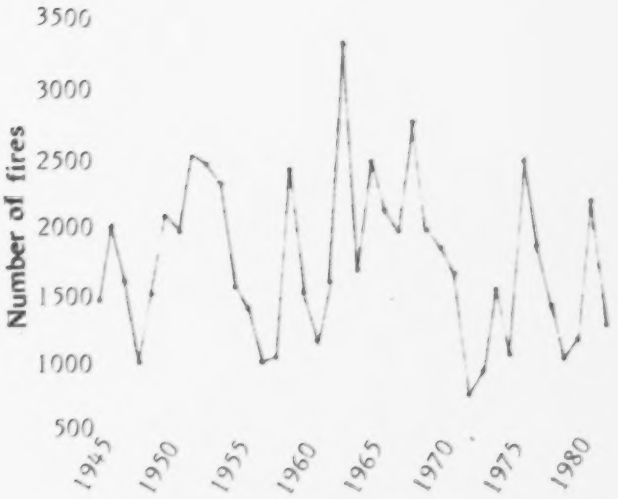


Chart A. Number of forest fires, 1945-1980

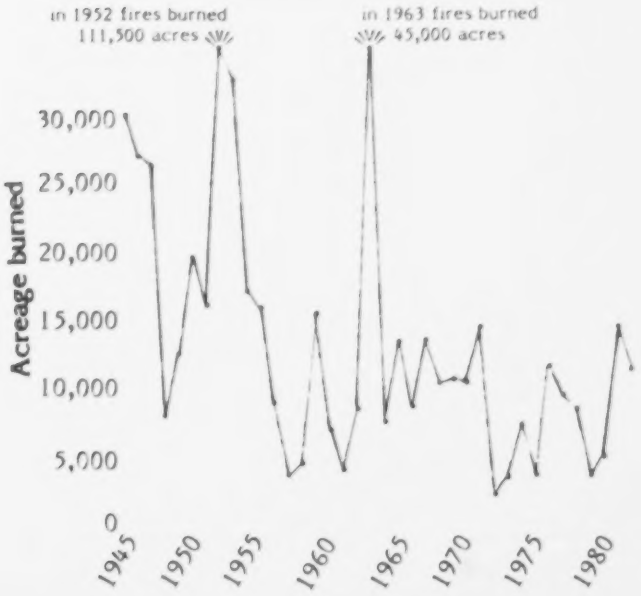


Chart B. Acres destroyed by forest fires, 1945-1980

II. A. 2. **Importance of keeping wildfires out of the woods**

a. Uncontrolled fires destroy or damage trees by killing the cambium layer, thus destroying a vital link in their food manufacturing process, and by completely consuming the trees--especially the seedling, sapling, and pole-size trees. Also, charred wood is not acceptable by pulpwood, crosstie, or pole buyers.

b. Wildfires reduce the water-holding capacity of the soil. The leaf litter and humus form a spongy layer which soaks up the rain and snow. With the leaf litter removed, water is permitted to run off rapidly, increasing flood possibilities, and soils are easily eroded.

c. Uncontrolled fires result in poor hunting and fishing. Quail eggs baked by fire will never hatch, and fish will starve in a stream choked with mud and poisons leached from wood ashes.

d. Uncontrolled fires affect general economy. Virginia's forests are vital to the state's economy, and anything which adversely affects the forests adversely affects the whole economy.

3. **Causes of uncontrolled fires**

CHART C--CAUSE OF FOREST FIRES IN VIRGINIA BY PERCENTAGE

Cause	Percentage
Debris burning	28
Smoking	18
Incendiary	16
Children	8
Railroad	8
Machine use	8
Campfires	2
Lightning	1
Miscellaneous	11

Note from Chart C that people are responsible for 99 percent of forest fires. Since this is the case, people must be taught to be careful and should be reminded periodically of the following rules:

a. Crush cigarettes, cigars, pipe ashes, and matches into damp earth. In a car, use the ash tray.

b. Carefully extinguish camp fires or warming fires--use damp earth, or water, or both.

c. Burn brush or trash in small piles, away from woods or dry grass, on calm, damp days.

d. Never build a fire in a hollow tree to smoke out game.

II. A. 4. **Fire detection methods**

a. **Lookout towers**

Most forest fire lookout towers are from 100 to 120 feet high. They are usually used as observation posts during the fall and spring, when fire danger is the greatest. The lookout operator has communication with fire suppression units through radio and telephone. When a "smoke" is spotted, the lookout lines up the alidade (much like sighting a rifle) which is mounted on a swivel in the center of a map. The alidade gives the compass direction of the smoke from the tower and is calibrated to estimate distance. The lookout calls other towers to get their compass (azimuth) bearings on the smoke. The intersection of these lines of sight (azimuth bearings) identify location of the fire. The exact location is then reported to the fire suppression crews. The lookout tower system of fire detection is supplemented by the use of aircraft.

b. **Aircraft**

During high-hazard fire weather, airplanes are used. The planes fly preset flight patterns, usually of two to three hours' duration and covering hundreds of square miles. The pilot and fire observer keep a sharp lookout for "smokes." When smoke is observed, they circle to determine if the cause is a wildfire, a controlled burn, or a law violation. The fire location and other pertinent information are radioed to the fire dispatcher. If a wildfire is observed, the plane may circle the area to advise the ground crews on the best access roads and trails and the deployment of suppression forces.

5. **Forest fire laws**

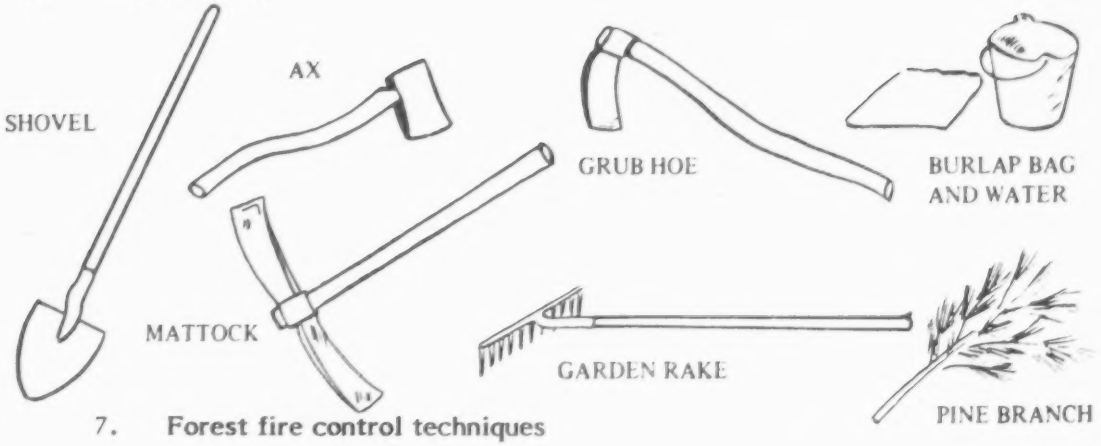
Forest laws should be studied in detail. The laws are published in the State Code books and in the Virginia Division of Forestry publication No. 2. Copies of publication No. 2 are available from the Division of Forestry at no charge.

a. Four o'clock burning law: During March 1 to May 15, it is unlawful to have a fire within 300 feet of the woods, dry grass, or brush leading to the woods except after 4 p.m. The fire must be extinguished by midnight.
b. It is unlawful to leave a fire unattended if in or near the woods, dry grass, or brush leading to the woods.
c. It is unlawful to toss a lighted match, cigarette, firecracker, or any burning device from a vehicle.

6. **Actions to take when a fire gets out of control**

a. Notify the nearest forest warden, fire department, or sheriff's office; then begin control measures.
b. Make note of how fire started. This can be helpful to the forest warden.
c. Tools and equipment for fire fighting which are usually available at home are shown at the top of the next page.

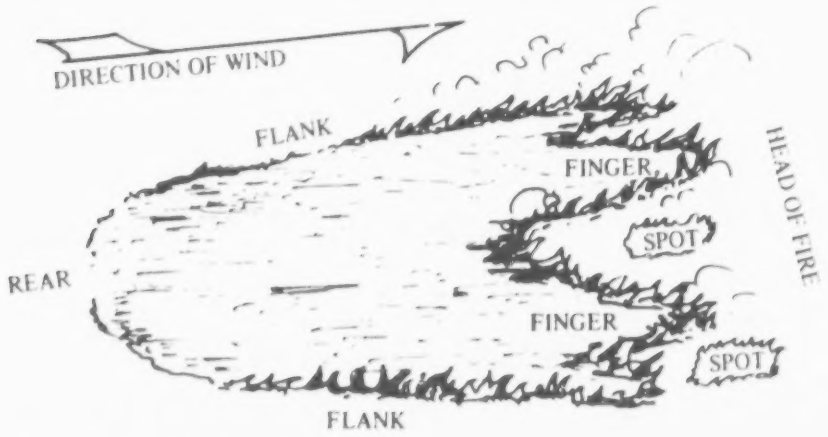
II. A. 6. (Continued)



7. **Forest fire control techniques**

a. **Parts of a fire**

(1) Head--fast moving portion of fire
(2) Spot--new fires set by sparks blown ahead by wind
(3) Rear--slow moving part of fire--usually close to point of origin of fire
(4) Flanks--sides of fire parallel to direction of movement



b. **Diagnosis of the situation**

Scout the fire for following information:

(1) Location of fire head or heads
(2) Types of fuel burning and types of fuel in advance of fire
(3) Rate of spread of fire
(4) Approximate size of fire
(5) Topographical features such as roads, streams, swamps, hills, etc., which may affect the fire's behavior
(6) Best routes to move in workers and equipment
(7) Number of workers, tools, and types of equipment needed to suppress the fire

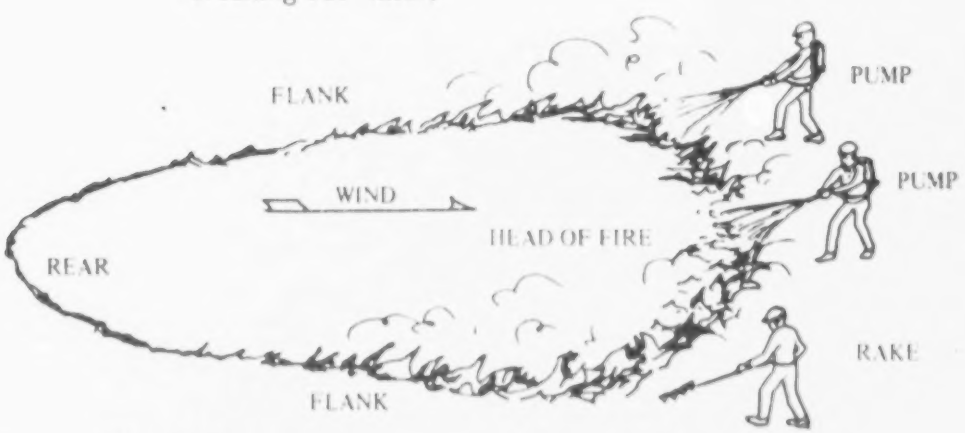
II. A. 7. c. **Methods of controlling a forest fire**

Forest fires are usually controlled by cutting off the fuel supply. A line is built around the fire; the area burned out between the constructed line and the wildfire will remove the fuel. This is known as "burning out the line." A fire line is made by digging away all leaves, grass and twigs (anything that will burn) down to mineral soil for a width of approximately 2 feet. Care must be taken to remove logs, roots or any materials which will carry fire across the line. Roads, streams and cultivated fields can serve as fire breaks.

There are two general methods used in controlling a forest fire:

(1) **Direct attack**

This method often used on a slow-burning fire where firefighters can work close to the fire. The flames may be knocked down with water, earth, a pine bush, or wet burlap bag, and a fire line may be built at the edge of the fire by pushing leaves and other burnable material into the fire. A clean line must be constructed around the fire edge to assure final control and prevent the fire from "breaking out" later.



(2) **Indirect attack**

This is used when the heat and rate of spread will not permit working near the flames. The following rules must be followed when locating and building fire lines:

(a) Stay as close as heat will permit behind the fire line.

(b) Do not build line through patches of dense undergrowth. It is slow going and difficult to make safe.

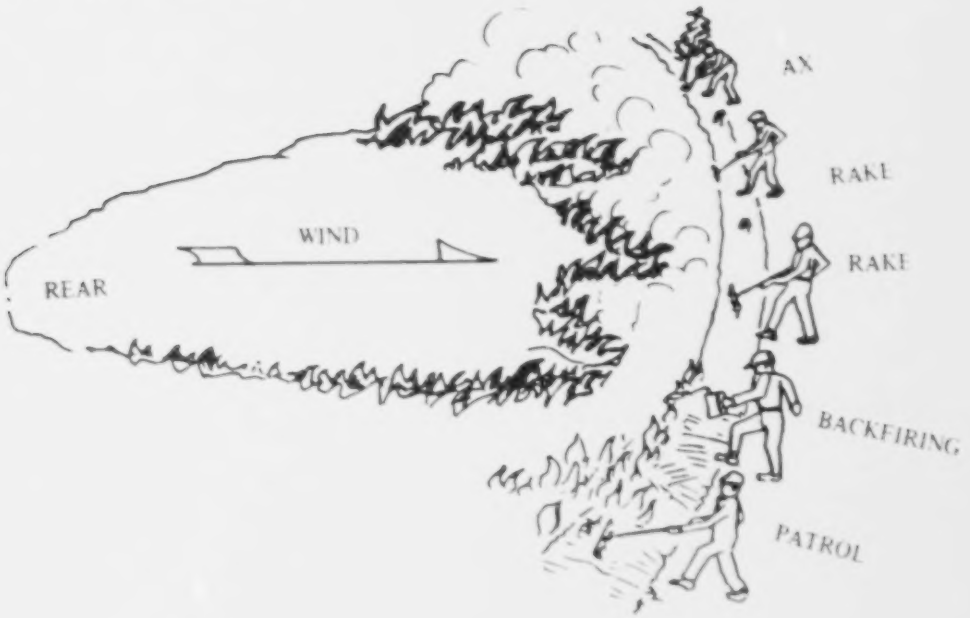
(c) Build fire line in front of stumps, logs, snags, and brush heaps to keep them from catching fire. They may scatter fire across the constructed line.

(d) Do not make sharp turns in line.

(e) In hilly or mountainous country, build line so that burning embers will not roll across fire line.

Caution: Keep workers on the alert for fire crossing the line. Fire line building is hot, dirty, expensive work and unless the line is protected, all the work is wasted.

II. A. 7. c. (Continued)



d. **Mechanized equipment**

(1) **Tractor/fire plow unit**

Much firefighting is done on foot; however, mechanized equipment is necessary for transporting workers and supplies. One of the most cost-effective pieces of equipment is the tractor/fire plow unit. The plow is designed to dig a trench down to mineral soil and throw a "furrow" about four feet wide. This makes an excellent line for the line-firing or back-firing crew.

(2) **Aircraft**

Many techniques have been tried and are continuing to be developed which use aircraft for fire suppression. In certain areas of the nation, large bombers are used for water drops. In Virginia, however, the present use is concentrated on water buckets slung beneath helicopters. Most sections of the state have adequate water supplies (streams, ponds, or lakes) within several minutes flying time between the water source and the fire. The helicopter operator drops the bucket into the water supply, winches it up and transports it to the fire. The water released is controlled by an electrically activated device in the cockpit of the helicopter.

e. **Mopping-up operation**

The job of controlling a fire is only partly completed when the line is built. The fire line must be carefully inspected and weak spots cleaned up. All burning snags near the line should be felled. Burning logs near the line should be rolled back into the fire area and covered with earth or soaked with water, and burning stumps should be covered or carefully watered. No fire is safe until every spark is out.

II. A. 7. f. **Safety**

Forest fire fighting is hot, dangerous work. An injured worker is of no value on the fire line. Always keep a safe working distance between workers. The tools used are sharp and dangerous. Keep an eye on the main fire and constantly check the terrain, so that a safe exit can be made if the fire changes its course. The welfare and safety of the workers should have top priority in fire fighting.

8. **Forest fire control agencies**

a. **State agencies**

(1) The Virginia Division of Forestry is charged with the protection of all 14.5 million acres of state-owned and private forest land. Professional fire fighters and specialized equipment are available through the district forester's office.

(2) All areas of the state have paid or volunteer fire departments, many of which are equipped to fight forest fires.

b. **Federal agencies**

(1) United States Forest Service has two national forests with ranger stations and forest wardens strategically located throughout.

(2) National Park Service has two large and several small national parks with ranger stations and forest wardens strategically located throughout.

c. **Private agencies**

Many large forest industries maintain forest fire suppression units for fighting fire on industrial and neighboring forest land.

B. **Forest insects and diseases**

Insect and disease pests cause timber losses by killing the trees they attack, by retarding growth, or by reducing quality. In addition, loss of natural forest beauty and watershed protection may occur when trees are killed over large areas. On a national level, these combined losses exceed $900 million annually. In Virginia, losses for annual mortality alone is conservatively estimated at 24 million board feet of sawtimber-sized trees (enough to build 2,400 five-room houses).

Much of the insect- and disease-caused losses in Virginia can be prevented or reduced by woodland owners who have a general understanding of the habits of the more destructive pests. If trouble is noted early and help obtained from a forester, inexpensive and practical control is often possible.

1. **A few of the most important forest insects**

a. **Bark beetles**

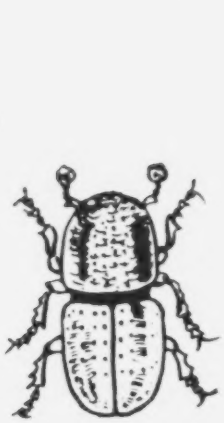
There are many species of bark beetles, and both hardwoods and pines are subject to attack by one or more species. In Virginia, the pines are most widely and severely attacked, and outbreaks of bark beetles occasionally kill many acres of pine timber. In 1976, bark beetles killed more than 80 million board feet during one year of outbreak. Those attacking pine include southern pine bark beetles, Ips beetles, and turpentine beetles.

II. B. 1. a. (Continued)

Adult bark beetles bore through the bark and construct galleries between the bark and wood where the female lays eggs. In pine, the entrance hole is usually surrounded by exuded pitch, which hardens into popcorn-like pitch tubes. These pitch tubes may occur along the entire length of the bole. Healthy trees often withstand attack by drowning the beetles with copious pitch flow; trees weakened by drought or other agents have little chance of withstanding attack.

Pine bark beetle attack is almost invariably accompanied by infection of the wood-staining fungi, which contribues to the ultimate death of the tree.

Successful attack by bark beetles can be prevented by keeping woodland trees in a vigorous and healthy condition through periodic thinning and timely harvesting. Prompt salvage of infested trees is one effective and inexpensive control method. Control with insecticides should be as recommended by the local forester or county agent.



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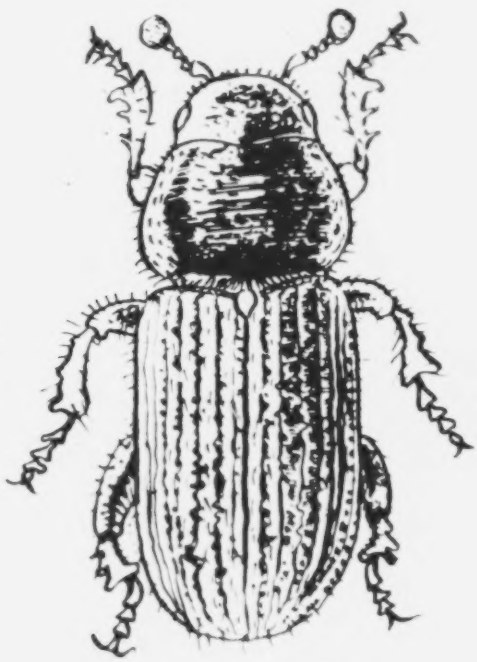

BLACK TURPENTINE

SOUTHERN PINE

II. B. 1. b. **Gypsy moth**

This pest is a native to Europe and Asia. It was introduced into Massachusetts in 1869 in an attempt to develop a hardy race of silk-producing moths. The pest escaped from the laboratory and gradually spread throughout the northeast. By 1980, it had developed a foothold in northern Virginia, several isolated spots in Floyd and Charlotte counties, and several other areas.

The gypsy moth has four life stages: egg, larva (caterpillars), pupa, and adult. The damage to trees is caused by the removal of foliage by feeding caterpillars. In Virginia, the caterpillars begin feeding in late April and usually cease about early July. They then go into the pupa (resting state) for 10 to 17 days. Adult moths emerge, mate, and the females deposit egg masses on any surface available. The egg masses overwinter and the cycle repeats.

The favored tree species for the caterpillars are the oaks and most other hardwoods. To date, there are no practical control measures for most of the forest land, but there are means of controlling the gypsy moth in high-value residential and recreational areas.

c. **Pales weevil**

Pine and other coniferous seedlings may be killed by this one-half inch long beetle which girdles the seedlings as it feeds on the inner bark and cambium. It is nocturnal in habit. The weevil is attracted to areas where pine has been recently cut, and under Virginia conditions will remain in the cutover area for almost a year. It is a threat to pine seedlings (planted or natural) within and around such cutover pine areas. This insect may also feed on the branch tips in Christmas tree plantations.

It is advisable to delay planting seedlings for one year in a cutover pine woods to avoid losses. In Christmas tree plantations, freshly cut stumps may be treated with an insecticide. In forest tree plantations, when a delay in planting is impractical, it is more economical to treat seedlings by dipping them in a suspension of insecticide prior to planting.

d. **Woodborers**

These insects seldom kill a tree, but they often render it useless for high-value wood products such as furniture, veneer, and oak flooring. Losses from borer-caused degrade in lumber and related wood products in southern oaks alone is estimated at $60 million annually.

There are many species of woodborers; some attack standing trees, some logs, some lumber, and a few attack wood products already in use. Wood-staining fungi are often associated with woodborer attack.

II. B. 1. e. **Pine tip moth**

The larvae of the pine tip moth bore into the growing tips of young pine trees. They are particularly injurious to trees under 7 feet in height. Damage can be recognized by dead twig tips and the distorted bushy appearance of the side branches. The tree is seldom killed, but height growth is retarded. Tip moth damage is more severe in plantations on old field sites than in pines planted on cutover areas where the soil pH is lower.

2. **Forest tree diseases**

Diseases of forest trees are generally less spectacular than insect damage, since fewer trees are killed outright. The heart-rotting fungi cause by far the greatest loss in timber values--exceeding the losses caused by fire, insects, animals, or weather. In Virginia, heart rots account for an estimated 80 percent of the total growth loss attributed to diseases in the forest. Refer to the color brochure and text on pine diseases available from the instructor.

a. **Oak decline**

Scarlet oak, and other species of oak to a lesser extent, periodically suffer extensive die-back and death during periods of prolonged drought. Insect defoliation and shallow soils have contributed to this extensive "decline" over thousands of acres in the western third of the state in the mid-1950s and again in the mid-1960s.

Salvage and sale of the affected timber is the only method currently available to reduce dollar losses.

b. **Heart rots**

Wood-decaying fungi can enter trees through various wounds, old branch stub scars, or from the parent stump in the case of sprout growth. Large scars (even if healed), bleeding, abnormal swelling along the trunk, or the presence of conks or toadstools of the rot fungus are indicators of decay.

Defective trees should be cut and sold to salvage value remaining; non-saleable defective trees should be poisoned or felled to make room for unaffected neighbors.

c. **Oak wilt**

A potentially serious threat to the oak forests of Virginia, this wilt fungus causes infected red oaks to exhibit characteristic symptoms including premature discoloration and extensive leaf fall in early summer (many fallen leaves are still green). Positive diagnosis can be made through laboratory testing by the Virginia Division of Forestry. Currently this disease is confined to forest areas west of the Blue Ridge Mountains in Virginia. An annual aerial survey by the Division of Forestry keeps tabs on the intensity and spread of this disease.

C. **Animals as damaging agents to forests**

1. **Livestock**

Woodlands at best make very poor pasture. Livestock damages the woods by eating and trampling the young hardwood seedlings and sprouts and by packing the soil so that air and moisture are kept out.

II. C. 1. (Continued)

The trampling of roots or larger trees also is detrimental. Livestock grazing of woods is detrimental, especially in the piedmont and mountain forests of the state. If shade is needed for livestock, a small area of the woods should be fenced off for their use.

2. **Other animal pests**

Mice are especially damaging to young plantations, because they strip the bark from the bases of seedlings. If a heavy mouse population is suspected, control measures should be taken. Poison bait, composed of 2 percent zinc phosphide, treated oat groats, and No. 4 cracked corn mixed with mazola oil should be mixed, 100 parts bait with 1 part zinc phosphide by weight and broadcast 6 to 8 pounds per acre.

Caution: Care should be taken to avoid poison contact with the skin.

Deer have not become a serious pest but as herds build up, steps may have to be taken to protect young stands from overbrowsing. Repellents may be used for deer control.

Unit 16 – Selecting a Career

TASK ANALYSIS:

Performance Objective

Given research guidelines, necessary references, and a list of forestry-related careers, prepare and present a short oral report to the class on a selected occupation of interest. Report must contain an explanation of job duties, working conditions, preparation or training required and sources of training, projected employment outlook, estimated entry-level wages, and advancement opportunities.

Selected Enabling Objectives

1. Identify unskilled, semi-skilled, skilled, technical, and professional jobs related to forestry.
2. Define job title, job duties, working conditions, projected employment outlook, entry-level, and advancement opportunities.
3. Identify information which can be secured from the Dictionary of Occupational Titles, Occupational Outlook Handbook, and other selected references.
4. Identify criteria for an effective oral report.

Criterion-Referenced Measure

Prepare and present a short oral report to the class on a selected occupation of interest. Report must contain an explanation of the job duties, working conditions, preparation or training required and sources of training, projected employment outlook, entry-level wage estimation, and advancement opportunities.

Selected Instructional Activities

1. Introduce students to available references on forestry-related careers, discuss types of data contained in each, and demonstrate how to use each reference for research.
2. Have students define terms concerned with careers in forestry and related research.
3. Invite selected persons employed by various local forest industries to talk about their jobs to the class.
4. Invite the school guidance counselor to speak to the class on various aptitude and interest surveys available to students searching for occupational goals.
5. Collect catalogs from private and public postsecondary schools that offer a forestry curriculum and provide time for students to study these catalogs.
6. Discuss and demonstrate how to make an effective oral report. Have students develop an evaluation checklist which includes the elements of good public speaking; if desired, have students evaluate each other's oral reports according to the checklist.

Selected Tools and Materials

Instructor-prepared research guidelines
College and training institute catalogs
Filmstrip projector and screen

Selected Audiovisual Materials

Filmstrip: Virginia's Forests--Careers in Forestry. Filmstrip No. 10, Virginia Forest Series (#01750). Audiovisual Services, Virginia Department of Education.

Selected References

Agricultural Education Service Area Resource. Agricultural Education, Virginia Department of Education.
Careers in Forestry. USDA Miscellaneous Publication 249.
Dictionary of Occupational Titles, 4th ed. U.S. Department of Labor.
Occupational Outlook Handbook, 1980-81 ed. U.S. Department of Labor.
So You Want to Be a Forester. Charles Edgar Randall.
Virginia Occupational Demand, Supply, and Wage Information, 1982 ed. Virginia Occupation Information Coordinating Committee (VOICC).
Virginia VIEW (Vital Information Education Workshops). VPI. (free career search microcomputer software or microfiche cards)
What You Should Know About Career Opportunities Offered by the Pulp and Paper Industry. Technical Association of the Pulp and Paper Industry.

LESSON PLAN:

I. PREPARATION

A. Lesson approach

The growing, harvesting, processing, and marketing of forest products involves a large percentage of the national working population. One in every nine workers engaged in manufacturing works directly with wood.

Wood in some form is used by everyone almost every day. The American economy could not exist without a continuous flow of wood and other products from the forest, through the factories, and to consumers. To maintain a constant flow of forest products and to assist people in obtaining the benefits provided by the forest require personnel trained in a multitude of different skills.

In addition to employment connected directly with the forest and its allied industries, there is a wide variety of jobs involving other products from the forest. Of growing importance are wildlife management and outdoor recreation careers, which involve employment opportunities for semi-skilled and skilled workers, technicians, and professional personnel.

Multiple-use forestry and wood-using industries employ people in many correlative jobs: writers, photographers, salespeople, trappers, timber cruisers, scaler guides, fire wardens, conservation officers, and surveyors, to name a few. Young people who want to work outdoors or in some phase of forest resource can find job opportunities appealing to their special interests.

Many jobs in the field require vocational training; some require a technical school or college education. There are also opportunities for the high school graduate to advance through experience and on-the-job training.

B. General situation

1. Of the land area in the United States, 759 million acres, or 34 percent is in forest.
2. National and state forests are managed for the many products and values which can be obtained from them. While industry, farm, and other private ownerships are more likely to be managed for timber products alone, the trend is for them to be managed for related uses also.
3. As the amount of forest land is reduced due to demands for other uses, the intensity of management and the need for professional and technical help will increase.

C. State situation

1. Virginia has 64 percent of its land area in forests. The forest products industry is first in the number of manufacturing plants, first in the number of persons employed, and second in payroll.
2. Virginia forests are presently producing at about one-third of their potential. While the productivity of these forests is increasing, there is still a need for good forest management.

D **Local situation**

1. There is some forest-related industry in every section of Virginia.
2. Prior to unit study, the instructor should identify as many forestry-related job titles available in the local area as possible and divide them into unskilled, semi-skilled, skilled, technical, and professional categories.

II. PRESENTATION

The presentation, which may be duplicated for student use, follows the EVALUATION section.

III. APPLICATION

A. Based on the previous units of study, have students list the kinds of work involved in managing a forest, a wood-processing plant, or wood-using industry; then have them prepare a similar list which involves the management of forest-related natural resources for wildlife and recreational use.

B. After all students have presented their oral reports on selected careers to the class, have each student participate in a discussion identifying careers which meet their personal aptitudes, interests, and goals.

C. Have students investigate sources of training or education required for their selected careers by using catalogs to determine entrance requirements and courses offered.

IV. EVALUATION

As a minimum, the oral reports on selected careers should include those elements described in the criterion-referenced measure. If desired, the reports can be evaluated by means of the student-developed checklist.

FORESTRY CAREERS

II. PRESENTATION

A. Introduction to forestry careers

Today, forestry is more than fire protection and the growing of trees. Other products and benefits of the forest, such as water, wildlife, forage, and recreation, are becoming more important as our population increases.

New products and new production methods are demanding new skills for which training is being provided by vocational schools and colleges of forestry. These new jobs, both in the woods and in the factories, represent a variety of pioneering efforts which can be a challenge to everyone in forestry.

Jobs in forestry and related fields range from semi-skilled labor for which training may be obtained in a vocational school to positions which require training beyond high school.

B. Career information references

There are many references available which outline specific jobs in forestry in terms of duties, educational requirements, occupational outlook, current wage and salary information, working conditions, and opportunities for advancement.

1. Agricultural Education Service Area Resource. Agricultural Education Service, Vocational and Adult Education, Virginia Department of Education, 1984.
2. Dictionary of Occupational Titles, 4th ed. U.S. Department of Labor, Employment and Training Administration, U.S. Government Printing Office, 1977.
3. Occupational Outlook Handbook, 1980-81 ed. U.S. Department of Labor, Bureau of Labor Statistics, U.S. Government Printing Office, 1980.
4. Virginia Occupational Demand, Supply, and Wage Information, 1982 ed. Virginia Occupational Information Coordinating Committee (VOICC), Virginia Employment Commission, 1982.
5. Virginia VIEW (Vital Information Education Workshops). Virginia Polytechnic Institute and State University (free career search microcomputer software or microfiche cards).

C. Training required for selected forestry occupations

1. Unskilled

These jobs, consisting mostly of physical labor, require no specific education or training; they are in limited supply and many are being replaced by machines.

a. Brush cutter
b. Lumber piler
c. Pulpwood piler
d. Road worker

II. C. 2. **Semi-skilled**

These jobs require a high school education with training in forestry; in addition, they require decision-making skills and independent action and may lead to skilled occupations.

a. Equipment operator
b. Fire dispatcher
c. Log scaler
d. Park guard
e. Sawmill machine operator
f. Surveyor assistant
g. Timber marker

3. **Skilled**

Skilled job categories require specialized training beyond high school, which in some cases can be fulfilled by on-the-job training. Many job opportunities exist in these areas.

a. Dry kiln operator
b. Supervisor--mill, nursery, woods, yard
c. Head sawyer
d. Lumber grader
e. Master mechanic
f. Tree surgeon
g. Wildlife manager

4. **Technical**

These rapidly growing fields require a high school education plus one or more years of formal technical training; a year or more in a semi-skilled or skilled job can make formal study more meaningful.

a. Computer operator
b. Forest road designer
c. Radio technician
d. Research assistant
e. Timber cruiser

5. **Professional**

These occupations require a four-year college degree as a minimum. Success in these jobs leads to advancement beyond the specialties into administrative positions in industry, government, and high-level leadership positions.

a. Fire control officer
b. Forest entomologist
c. Forest pathologist
d. Forest soils scientist
e. Forest superintendent
f. Forestry instructor
g. Wildlife biologist

II. D. Employment in the wood-using industry

In contrast to the United States as a whole, where employment in the wood-using industry is approximately ten percent of all those engaged in manufacturing, in Virginia, about one in six workers is employed in this field. With two-thirds of Virginia land in forest, wood-using industries cover a wide range of products--furniture, paper, veneers, plywood, and particle board. Most jobs in the wood-using industry are semi-skilled, skilled, or professional.

E. Employers

Both private industries and public or governmental agencies employ workers in forestry-related occupations, mostly on the technical and professional levels. At one time, employment in private industry was limited, especially for field personnel. More recently, however, private industry has been both acquiring more forest land and practicing intensive forestry, which demand increasingly larger numbers of technical and professional employees.

F. Educational opportunities beyond high school

1. High school background

Students wishing to enter forestry school should have good communication skills and should take all the mathematics and science courses offered in high school. Almost all semi-skilled or supervisory jobs in forestry require the ability to read and comprehend instructions and a facility in mathematics.

2. Technical schools

Several schools offer highly specialized training for jobs in the lumber industry. Information may be obtained from the National Hardwood Lumber Association, 59 East Van Buren Street, Chicago, Illinois 60605.

Two schools which offer specialized one-year training in sawing, sawfiling, dry-kiln operation, and lumber grading are Haywood Technical Institute, Clyde, North Carolina 28721 and Michigan Technological University, Houghton, Michigan 49931.

3. Ranger-type schools

These schools offer programs lasting from one to two years, with emphasis on field work. Graduates most often are employed by state conservation departments and private industry.

a. One-year schools

Lake City Junior College and Forest Ranger School
Lake City, Florida 32055

New York State Ranger School
Wanakena, New York 13695

II. F. 3. b. **Two-year schools**

Lassen College Ranger School
Susanville, California 96130

Paul Smith's College of Arts and Sciences
Forestry Technician Unit
Mont Alto, Pennsylvania 17237

Sierra College
Forestry Department
Rocklin, California 94577

Thompson School of Applied Science
University of New Hampshire
Durham, New Hampshire 93824

Wayne Technical Institute
P.O. Box 1259
Goldsboro, North Carolina 27530

Dabney S. Lancaster Community College
Clifton Forge, Virginia 24422

4. **Colleges and universities**

Thirty-two institutions of higher learning have forestry curricula accredited by the Society of American Foresters; Virginia Polytechnic Institute and State University is one of these. Students interested in a degree program should contact the Division of Forestry and Wildlife Resources at the university for further information on program options and entrance requirements.

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APPENDIX A

Additional Information and Resources

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Tree Identification (slides). Ohio Agricultural Education Curriculum Materials Service.
Using Steel Tapes for Surveying (slidefilm). Vocational Agriculture Service.

Ordering Addresses

Agricultural Education Service
Virginia Department of Education
P.O. Box 6Q
Richmond, VA 23216

Allied Chemical Corporation
Nitrogen Division
40 Rector Street
New York, NY 10006

American Forestry Association
919 17th Street, NW
Washington, DC 20006

Audiovisual Services
Virginia Department of Education
P.O. Box 6Q
Richmond, VA 23216

Department of the Environment
Canadian Forestry Service
Ottawa, Canada

National Hardwood Lumber Association
59 East Van Buren Street
Chicago, IL 60605

National Wildfire Coordinating Group
Boise Interagency Fire Center
Division of Training
3905 Vista Avenue
Boise, ID 83705

Ohio Agricultural Education
Curriculum Materials Service
Room 254, 2120 Fyffe Road
The Ohio State University
Columbus, OH 43210

Southern Pine Inspection Bureau
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Pensacola, FL 30502

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APPENDIX B

Suggestions for Timber Sale Contract Provisions

The following provisions should be considered by timber sellers and their attorneys when writing a timber sale contract.

Description of timber offered for sale

1. Designate acreage and definite boundaries of the timber area offered for sale.
2. Stipulate which trees are to be cut. Describe method of marking selected trees to be cut. State volume of timber estimated in accepted units of measure.
3. Where seed trees have been selected, describe how they are marked or designated and stipulate that care be exercised to avoid damage.

Statement of agreed-upon purchase price and method of payment

1. Be certain method of payment is such that buyer cannot cut best trees and then move out. A lump sum payment or partial payments in advance for designated cutting areas can prevent this.
2. Make certain that purchase price is agreed upon and explicitly stated.

Logging restrictions and guarantees

1. Guarantee purchaser right of ingress and egress for workers, materials, and equipment.
2. Stumps should not exceed 12 inches in height unless defect at the butt requires a higher stump for safe felling. All trees must be felled inside the designated sale area.
3. All trees not designated to be cut (in seed tree cutting, all marked trees are designated to be left) should be protected against unnecessary injury in felling, skidding, and hauling operations. Unnecessary cutting of young trees should be prohibited. Tops and logging debris should not be permitted to be piled up around reserved trees or valuable young growth. These provisions are especially applicable for selection cutting, thinnings, and improvement cuts.
4. If the area is to be clear cut for even-aged management, provisions should be made to remove the majority of the standing timber to help replace the cost of site preparation treatments.
5. Existing roads on the sale area should be kept in passable condition during the operation and left in the same condition when the logging is completed.
6. The seller reserves the right to designate or approve the location of forest roads and skid trails in order to ensure adequate watershed protection. The seller also reserves the right to designate or approve access across cultivated fields, pastures, or other cleared lands. Skid roads and haul roads should be constructed according to BMP guidelines.
7. Any damage by the purchaser or agents of the purchaser to fences or other improvements of the seller shall be repaired or paid for by the purchaser.
8. Time limit for logging operation should be specified (usually 2 years or less, depending on size of the sale area.)

9. Provisions may be included describing the construction and removal of necessary logging structures.
10. Trees or logging debris cannot be deposited in stream channels or water courses. This is in violation of Title 62.1, Chapter 20 of the Virginia Code.

Fire protection and responsibility clause

1. The mill operator should be required to comply with the fire laws governing the operation of mill seat and burning pit areas. Clean mill areas aid in fire prevention. (See Section 10-64 and 10-65, Chapter 4, Article 4, Code of Virginia.)
2. All fires which may be burning at the mill in any slab pile or other debris shall be completely extinguished whenever the mill is not in operation, and no fire will be permitted to burn in the sawdust pile.
3. The purchaser should be required to immediately suppress any fires originating from negligence of the purchaser or agents. The purchaser will be liable for all damage to merchantable timber, standing or felled, young growth, or other property of the seller, which may be caused by such fires.
4. The purchaser should agree to aid in the suppression of any wild fires occurring on the sale area.
5. All provisions of the Virginia Seed Tree Law (Title 10, Article 6) must be met. Reforestation plans in lieu of leaving required pine or poplar seed trees must be prepared, submitted, and approved by the State Forester prior to cutting.

Penalty Clause

The stumpage price for undesignated timber which is cut should be stated (usually twice stumpage rate per MBF as indicated by the purchase price).

Assignment of Contract

Usually agreement is reached not to reassign any portion of the contract without the written consent of the seller.

Arbitration

Consider the need for setting up an arbitration board should a dispute arise. This usually consists of one person selected by seller, one selected by purchaser, and one selected jointly by those already appointed.

APPENDIX C

Plans for a Tree Planting Bar

Materials Needed

Handles – 6½", threaded 3/4" pipe

Tee – 3/4"

Shaft – 3/4" threaded on both ends. This arrangement permits changing length of bar to accommodate user.

Coupling – 3/4"

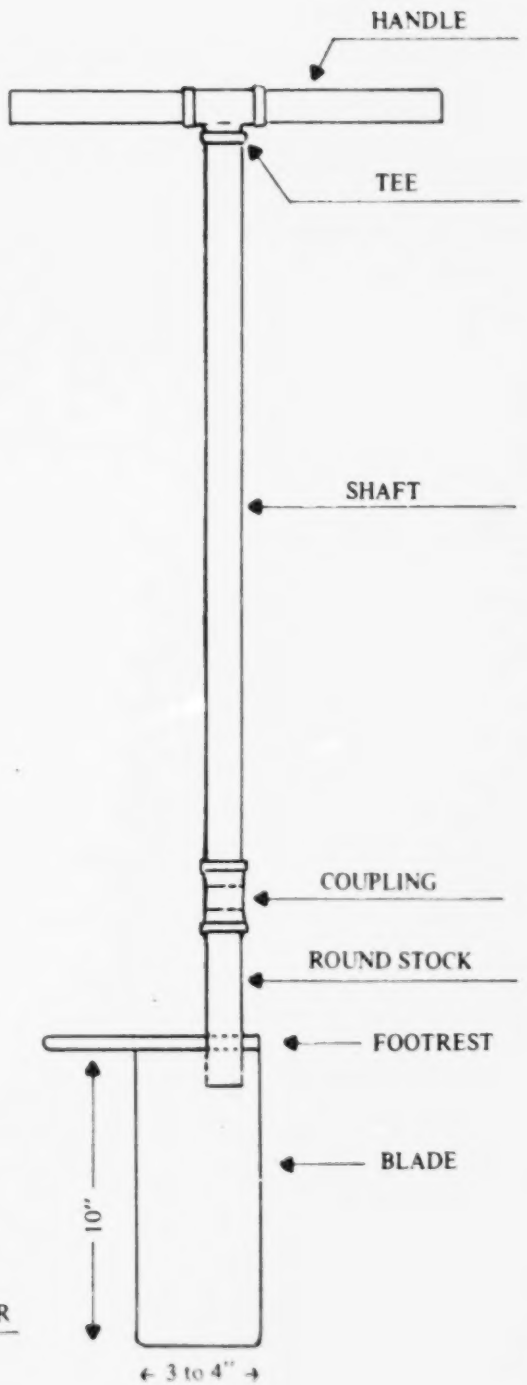
Round Stock – 3/4" threaded on one end. Total length 4"

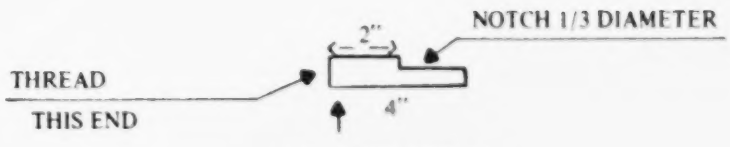
Footrest – 1/4" thickness x 3/4" width x 8" length.

Blade – Worn plowshare, cut to 10" length. Should be 3" to 4" in width. Sharpen on one side.

Weld footrest to top of blade. Notch round stock by 1/3 in diameter by 2" in depth. Overlap notch on footrest and blade. Weld on both sides.

Handle	Round Stock
Tee	Footrest
Shaft	Blade
Coupling	
Thread This End	2"
Notch 1/3 Diameter	4"
Round Stock	





ROUND STOCK

SCALE 2" = 1 FOOT

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